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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. . . LUCIEN W. MARSHALL, Manager
BOSTON OFFICE: 161 Devonshire Street . . . . . M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

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TROLLEY CARS IN THE FAR EAST.

An electric trolley system has been put into service in Hongkong, China. The construction of the road differs but little from the usual practice, only slight changes being made to conform to local conditions. The principal object of this road is to afford transportation facilities to the European residents of Hongkong, for the latter, being a British naval station and an important commercial centre, has a large number of English residents. It is said, however, that the native Chinese are now using the road a great deal, although they first viewed it with suspicion, believing it to be a contrivance of the devil's. They saw, however, that the cars would run, and that passengers were not spirited away, so they finally came, first to tolerate the road, and then to use it as a convenience. Until this road was started the principal means of transportation in Hongkong was the rickshaw, drawn by Chinese coolies. While slow, these are said to be reliable, as the coolies manage to get them around somehow or other. Now that the electric road is running, there is a fierce competition between it and the rickshaw, to which there can be but one ending.

The introduction of electrical apparatus in China and in other countries of the Far East can not but have some effect upon the lives of the natives. The people there change slowly, but probably nothing could have a greater effect than the trolley in bringing about this change, unless we except the telephone. Is it not possible that these two agents will play an important part in bringing about a better understanding between the Chinese empire and the western nations?

A MAGNETIC SURVEY OF THE NORTH PACIFIC OCEAN.

The undertaking of an important magnetic survey is contemplated by the Carnegie Institution, Washington, D. C. It is proposed to begin work this year on the North Pacific ocean, and an initial allotment of $20,000 has been made to cover the expenses for the year. This work will be carried out under the direction of Dr. L. A. Bauer, chief of the division of terrestrial magnetism.

The knowledge of distribution of the magnetic forces of the greater portion of this earth is unsatisfactory. This is particularly true of the oceans—those portions of the earth's surface where accurate knowledge of the magnetic conditions is most important. The conditions with regard to the Pacific ocean are more unsatisfactory than those of the Atlantic, for there has been but one magnetic survey of the former—that made during the famous Challenger voyage.

The Pacific ocean is becoming yearly more and more important as a highway of commerce, and an accurate magnetic survey such as that outlined in the article by Dr. Bauer, appearing on another page of this issue, will be of much value to vessels sailing the Pacific, besides being of great scientific interest and importance. The plan outlined for conducting this survey shows that the northern part of the ocean will be covered completely, and there is little doubt that very valuable results will be secured. The total length of the course outlined is about 70,000 knots. This will be sailed in sections, three years being the estimated time for conducting the work and reducing the observations.

This survey will give an opportunity for an instructive study of the magnetic distribution on land and water, for a magnetic survey is now being made by the United States Coast and Geodetic Survey in Alaska and in the United States. The first circuit of the Pacific survey passes along the American and Asiatic coasts, and the results of this, taken in connection with the land survey, should be especially interesting.

THE ACYCLIC DYNAMO.

The exceedingly interesting paper read by Mr. J. E. Noeggerath at the meeting of the American Institute of Electrical Engineers on Friday evening, January 27, takes us back to the earliest type of dynamo—the Faraday disc. This was a continuous-current dynamo, pure and simple, and not an alternator fitted with a commutator, as the continuous-current machine of to-day is. Since Faraday's time there has been a good deal of progress in the design of the so-called unipolar or homopolar dynamo, but all designers have failed to produce a commercial machine, because of the limitations of size, speed and magnetic qualities of our iron.

The step forward which has been made by Mr. Noeggerath is interesting, and has been the result of several factors. In the first place, the original limit of speed has been changed by the production of a commercial steam turbine. As the construction of the revolving part of the machine is simple, it can be made strong enough mechanically to take advantage of the high speeds available, and we may expect our acyclic dynamos of the future to run at peripheral speeds of from 12,000 to even 20,000 feet per minute. But even this terrific speed would not give a commercial voltage in a single disc or conductor unless it were too long to be practical; therefore Mr. Noeggerath has had to compromise by using a number of conductors connected in series by means of slip rings. In the particular machine described—which, by the way, is remarkable for its size and voltage, it being a 300-kilowatt, 500-volt machine—there are twelve conductors connected in series by means of twenty-four slip rings and brushes.

The high speed which it utilized in this machine would, under the usual conditions of brush friction, cut away the brushes and make collecting difficult, if not impossible; but it was found that at these high speeds there is a tendency to throw the brushes off the collector rings. This reduces the pressure, and consequently the brush friction. It does, however, increase the contact resistance, and in this way lowers the efficiency, but it does not appear that this effect is serious. Indeed, the efficiency given by the first machine constructed was about ninety-one per cent at full load, which is certainly a remarkable performance.

The acyclic dynamo offers some very decided advantages for the construction of direct-current machines. In the first place, there seems to be no necessity for laminating either the rotating or stationary parts, for by virtue of its peculiar magnetic distribution there is little tendency for eddy currents to be set up, and but little hysteresis loss. Perhaps "peculiar magnetic distribution" is hardly the proper way to describe the magnetization of this type of machine, for it is peculiar only by comparison with machines of to-day. The aim is to produce as uniform a distribution of flux as possible through the entire air-gap. Another advantage of this type is the perfectly uniform voltage given. There is no irregularity due to commutation, and the only variation which could be detected would be due either to an irregularity in rotation, or to some inequalities in the machine itself. The machine, too, offers some unexpected and valuable features: it can be made to compound itself by the simple process of shifting the collecting brushes, and it can even be made self-exciting. The regulation may be excellent, since the effect of the armature reaction when a good type is adopted tends merely to lengthen the magnetic path. In other words, it acts as a cross-magnetizing, and not as a demagnetizing, force. Since there is no commutator, and as it is said there is no difficulty in collecting current at the high speed of rotation, there should be no trouble from this source due to overloads or rapid changes in load. The machine requires in construction about half the copper necessary for the ordinary type of direct-current machine, and the fact that lamination need not be resorted to will reduce considerably the cost of the iron parts. Moreover, the air-gap need be only wide enough for mechanical clearance, thus reducing the magnetizing force to a minimum. It is, in fact, a cheap type of construction, and one which, from the results published, promises much. One can not doubt that newer machines of this type will show improvements; and since it is intended to be operated by a steam turbine it will share in the advantages of high efficiency and small floor space required, going with that class of equipment for central station work. Heretofore it has been the alternating systems which benefited chiefly by the development of the steam turbine, but now the direct-current systems may share equally from this late advance in steam engineering.

HIGH-SPEED RAILROAD IN GERMANY.

To Germany belongs the honor of having conducted the first successful experiments with running electric cars at very high speeds. Somewhat similar tests had been made previously on a small scale; but the German work was done with cars of standard size carrying persons. The results were satisfactory so far as they were carried, and they proved that speeds much higher than those now used could be attained safely if the necessary stability of track were secured. The tests further gave data of great value, covering the power required to move cars at these excessive speeds, and did much to clear up the erroneous views previously held.

Having carried this work to a successful issue, the question now receiving consideration in Germany is, shall a high-speed road be built between Berlin and Hamburg? Two propositions have been received by the German government from companies offering to construct a high-speed road between the two cities. One contemplates a single-track road, on which a speed of about ninety miles an hour would be maintained. The road would cost nearly $17,000,000. The distance is 177 miles, which can be shortened by a new route. The other proposition is for a double-track road. If the government is content with a speed of 100 miles an hour, the road would cost about $30,000,000. If a speed of 125 miles must be maintained, the cost would be nearly $36,000,000.

This shows that high-speed roads will be enormously expensive, and raises a doubt whether such roads would be profitable, since they must depend for their income upon the passenger traffic alone. The greater part of this cost will necessarily be in the roadbed, for not many cars will be required. There is some doubt

whether either of these offers will be accepted, for there is already a fair service between the German capital and Germany's chief seaport, and what traffic the new road would gain would be drawn principally from the older roads. The higher speed, however, would undoubtedly increase traffic between the two cities. The fare proposed is moderate, being only that which is now asked on the other roads. It would seem to be only just, however, to ask an increased rate on a high-speed road, because of the saving in time effected.

ELECTRIFICATION OF RAILROADS.

The electrification of steam railroads is progressing fairly satisfactorily, for it is now a topic for papers and frequent discussion before the engineering societies and those devoted to railway interests. At a recent meeting of the New York Railroad Club, a paper was read by Mr. W. B. Potter, which discussed developments in electric traction, and which brought out some interesting statements from prominent railway men present.

It is interesting to note that the cost of electrical equipment for the New York Central & Hudson River Railroad Company's terminal is, according to Mr. W. J. Wilgus, only about one-quarter of the total cost. But conditions in New York are peculiar, since the other work there is enormously expensive. Electrification, however, brings advantages which at first were not anticipated. It enables a road to go underground or above ground or along the ground, thus increasing three times the space available for tracks.

The method of collecting the current naturally came up for discussion, and there seemed to be a general leaning toward the overhead trolley wire and a collecting wheel. Mr. B. J. Arnold made the interesting generalization that in this country not one road in a thousand would pay if electrified with a direct-current system, but that nearly every road would pay if operated with an alternating-current system. Mr. Arnold believes the roads will be forced to electrify their systems for passenger service, and when this is done the freight service will naturally follow. He thinks that when the roads are run electrically the passenger service will be the principal part of the road's business. This will be a reversal of the present condition. It is hard to see how it can occur, unless we take to traveling a great deal more than we do now. There will surely be no diminution in the freight business.

The discussion of the electrification of steam roads seems to have entered into a sensible stage. The railway man is naturally interested in anything which can benefit his road, either by reducing expenses or increasing its business. The advocate of electrification is willing to explain the drawbacks of an electrical system, as well as to dwell upon the advantages which it would bring. This is an eminently satisfactory state of affairs, and will result in a thorough understanding. It is safe to say that there will not be a heedless rush to electrify, but where conditions seem favorable the prospect for electrification is exceedingly good.

REFUSE DESTRUCTORS.

The suggestion was made not long since by one of the New York papers that, by combining a garbage destructor with an electric light plant, sufficient electrical energy could be generated for all municipal buildings and city streets, without putting the city to any expense for fuel. On the face of it this seems to be a promising scheme, particularly as it would appear from obtainable statistics, that the fuel value of the city refuse would be more than enough to raise all the steam required for municipal lighting.

A little examination, however, shows that the conditions are not so favorable for such an undertaking as would at first appear. In a paper read recently before the Institution of Electrical Engineers, of Great Britain, by Mr. W. P. Adams, which was reported in the ELECTRICAL REVIEW recently, a complete study of the refuse destructors run in connection with the electric generating stations in England was given. There are in England seventeen such stations, which burn refuse and use the steam for generating electrical energy. Certain of these stations make other uses of the steam as well. It appears from this paper that the average performance of these seventeen stations for a year was less than twenty-five kilowatt-hours per ton of refuse. All of these stations require, in addition, a great deal of coal, the proportion of coal to refuse being sometimes as great as twenty-five per cent. It will be seen from this that it is out of the question to run an electric lighting plant by means of refuse alone, and not use some coal.

Moreover, the conditions obtaining in an electric lighting plant are such that it must be possible to meet sudden and great demands on the station quickly, and for this purpose city refuse is about as bad a fuel as can be imagined. If it were possible to run along at a uniform load for twenty-four hours, and store up energy in an accumulator during periods of light load to help over periods of heavy load, it might be done, but this would require an outlay for a storage battery so great as to make the undertaking impractical. Then, too, some means would have to be provided for destroying the excess refuse which could not be used for raising steam. It would hardly seem to be wise to attempt to burn this in destructors used for raising steam.

It is, of course, a wise policy to save, wherever possible, and not throw away anything that can be used, and as city refuse has a certain fuel value it would seem to be desirable to use it for fuel. If this were done in connection with a municipal lighting plant it would be desirable—and probably necessary—to have the plant located within New York city, and this would bring about a condition which would probably not be tolerated, for refuse destructors are undoubtedly a great nuisance to a large tract of surrounding territory. They not only give off obnoxious odors, but they scatter smoke and dust and are an annoyance generally. On the other hand, if the plant could be installed some distance outside of the city, this objectionable feature would be eliminated, but others would be incurred. The expense for transporting refuse to the destructor—which, in the plan proposed was to be avoided, it being delivered at the destructor by the collecting carts—would still be necessary, and the trouble and expense of getting the current to the city would have to be considered. There are, no doubt, a great many localities in this country where a destructor and an electric lighting plant could be combined with benefit, but New York does not seem to be at all suited to such an undertaking.

Storage Batteries for Block Signal Work.[1]

The method of electric supply for the operating of railway interlocking and signaling apparatus is reaching a point of the greatest refinement. Within the past few years the attention of signaling engineers has been turning with greater and greater concentration toward the best method of supplying signaling and interlocking devices with electric current, and the result is indicated by the rapid increase in the use of storage cells for this purpose. With storage batteries it is necessary to provide a charging source, and provision must be made either for carrying the charging current to the batteries over a transmission line (the batteries being placed permanently at the working points), or the batteries must be of portable form and transported to and from the charging station. Which method shall be adopted in any given case is dependent upon the geographical distribution of the devices to be served. In the case of transmitting current to the battery points for recharging, we have the additional investment in transmission line, extra power required to compensate for the line loss, the greater number of cells than is required for portable work, and the somewhat larger generator. In a portable plant, on the other hand, we have a somewhat more expensive form of battery, due to the fact that it is necessary to install a larger size of cell and to use rubber jars instead of glass. In addition to this we have, in some cases, the extra expense of transporting cells. In deciding, therefore, which method shall be used, a careful comparison of these various items should be made.

The Southern Pacific Company has been using storage batteries in signaling work for several years, and on that portion of the road between Truckee, Cal., and Sparks, Nev., there are sixty-six signals operated from forty-one battery locations, each battery set consisting of four cells of type 5-PV Exide, having a capacity of fifty-five ampere-hours at eight volts. These four cells are mounted in two wood cases, two cells to each case, handles being provided so that they can be readily transported. Each case of cells weighs approximately twenty-five pounds. These four cells, connected in series, are used for one signal or for a pair of signals, provided they are not a greater distance apart than 500 feet. Once a month the cells are placed on a car and returned to the charging station to be inspected and recharged. It is customary to charge these cells in sets of seven, four cells to each set, making twenty-eight cells in all. The batteries, when recharged, are distributed to new locations and exchanged for other cells which have been in use for a month.

A total of 164 cells supply sixty-six signals, or approximately two and one-half cells in operation per signal. Ordinarily fifty-six extra cells are kept in the charging station and exchanged for others which become discharged, so that the total number of cells for the normal operation of this section of the road would be 220, or three and one-third cells per signal. This is approximately six cells per mile of track. It is estimated that it costs ten cents per kilowatt-hour for charging the batteries, which is less than $1 for each set of four cells per year, or $55 per year for the total number of sets. The cost of the charging station is approximately $300. This figure is exclusive of the building. A gas engine is used to drive the generator.

With these sixty-six signals, if primary cells were used, it would be necessary to have sixteen cells for each signal, because it is not practicable to connect two signals to one set of primary cells; consequently, for the sixty-six signals 1,056 primary cells would be required. The cost of these cells is in the neighborhood of $2.50 each delivered on the coast, and the cost of material for maintaining the same is reported as $1 per cell per year, or a total fixed maintenance expense of $1,056 per year. The maintenance of the storage battery plates for this entire section is estimated at $200 per year. The first cost of the 220 Exide cells will be approximately $1,200. A comparison of the first cost and the operating cost will appear as follows:

FIRST COST.	
1,056 primary cells at $2.50	$2,640.00
Cost per mile of single track	69.50
220 storage cells	1,200.00
Charging plant	300.00
Total	$1,500.00
Cost per mile	39.50
Increase in first cost of primaries over storage	75%
MAINTENANCE.	
Maintenance on 1,056 primaries for one year	$1,056.00
Maintenance per mile	27.80
Maintenance on 220 storage cells for one year	200.00
Charging current for one year	55.00
Total	$255.00
Maintenance per mile	6.70
Increase in maintenance cost of primaries over storage	317%

The question of first cost and operating expense having been settled in this instance to the marked advantage of the storage battery, it remains to be determined whether the storage battery system possesses any points of advantage in actual operation. One point that impresses the engineer immediately is the fact that four cells of storage battery replace sixteen primary cells, and there is a corresponding reduction in the number of connections and units requiring attention. The chances of failure due to broken or bad connections are very much reduced by the use of the storage cells. With the old primary cell system fully half the signal failures were due to the primary cells. Another point of great advantage for the storage cell is the difference in available capacity. It may happen that one semaphore, for some reason or other, is working a great number of times within a short period. In a case like this a signal, after a number of movements, will work very slowly, or possibly not at all. This is due to the polarization of the primary cells, and this effect is not perceptible in a storage cell. In consequence, with the storage cell operation is always sure.

[1] Abstract of a paper, by Mr. Edward L. Reynolds, read before the Railway Signal Association, New York, January 10, 1905.

The Institute Annual Dinner.

Preparations for the annual dinner of the American Institute of Electrical Engineers, which will be held in the grand ballroom of the Waldorf-Astoria, New York city, February 8, are being pushed actively. As already announced, the dinner will be devoted to signalizing the triumphs of electric traction. It is understood that some original and novel features will be included. Messrs. Frank J. Sprague and Leo Daft will speak for the Institute pioneers in electric traction. There will be exhibited for the first time the oil painting recently presented by the Institution of Electrical Engineers, of Great Britain, as a souvenir of last year's visit. This represents Dr. Gilbert making magnetic experiments before Queen Elizabeth. The bust of Professor Ferraris, presented to the Institution last year, will be exhibited in the Astor Gallery reception room.

Electrically Propelled Gyroscope.

At a meeting of the New York section of the American Electrochemical Society, held January 24, 1905, Mr. Edward Durant described an electrically propelled gyroscope. The revolving part of the wheel forms the armature of an electric motor, and the inner gimbals form the magnetic field. Current is conveyed to the motor by way of the trunnions and gimbals, and the revolving part may thus be kept in motion indefinitely.

The New Canal Telephone Exchange at Cincinnati, Ohio.

By J. E. Peavey.

THE completion and cutting into service on the afternoon of November 19 last of the new telephone exchange known as the "Canal" marked an era in the successful history of the Cincinnati & Suburban Bell Telephone Company.

The present management has endeavored by the best methods known in the art to place at the disposal of the appreciative public the very best of service. The success of its efforts can be best attested by the subscription list, which has doubled its numbers in the short period of three years, necessitating an addition of eight new exchanges and five new exchange buildings within the city of Cincinnati exchange district. The "Canal" exchange, located at the southeast corner of Race and Canal streets, is the latest addition.

The building is three stories high with a deep, well-lighted and well-ventilated basement. The outside walls are of Kittanning and iron clay brick with freestone trimmings; all inner walls and partitions are of hollow fireproof tile. The supporting framework is of steel and all staircases are of steel and white Italian marble. On the sides of the building, in close proximity to other buildings, metal casings and window frames have been used with wired glass. Loricated iron conduit is used throughout the building for all power and light wires—each floor having a steel and slate junction box and outlet, and also electric light switches have been conveniently arranged throughout the building in a manner that will ensure economical use of the light. Every precaution has been taken against damage by fire and it would hardly be possible for fire to originate or be maintained within this building, which is one of the most important items in modern exchange construction.

In designing this exchange careful consideration was given to the present demands and as near as possible to what the future development may be. The building has an ultimate capacity of 9,600 subscribers and 2,000 trunk lines; full equipment to accommodate this number of lines can be installed without making any changes in apparatus or building. A careful study was also made of the relation of the operators' quarters to the operating room; inspectors' quarters to the wire chief, also isolation of employés in the maintenance department from the operating department.

Fig. 1 is the third floor which is used exclusively as an operating room. There are no columns or anything that would obstruct the view. Switchboards already installed are shown in full lines and those provided for in the future are shown in dotted lines. It will be seen from the drawing that there are two entrances to this room by staircases from the floor below, one landing directly in front of the chief operator's desk is used by the operators; the other shown in lower right-hand corner of drawing being used exclusively by the maintenance department when they have occasion to enter the operating room. It will be seen from this plan that there will be a minimum

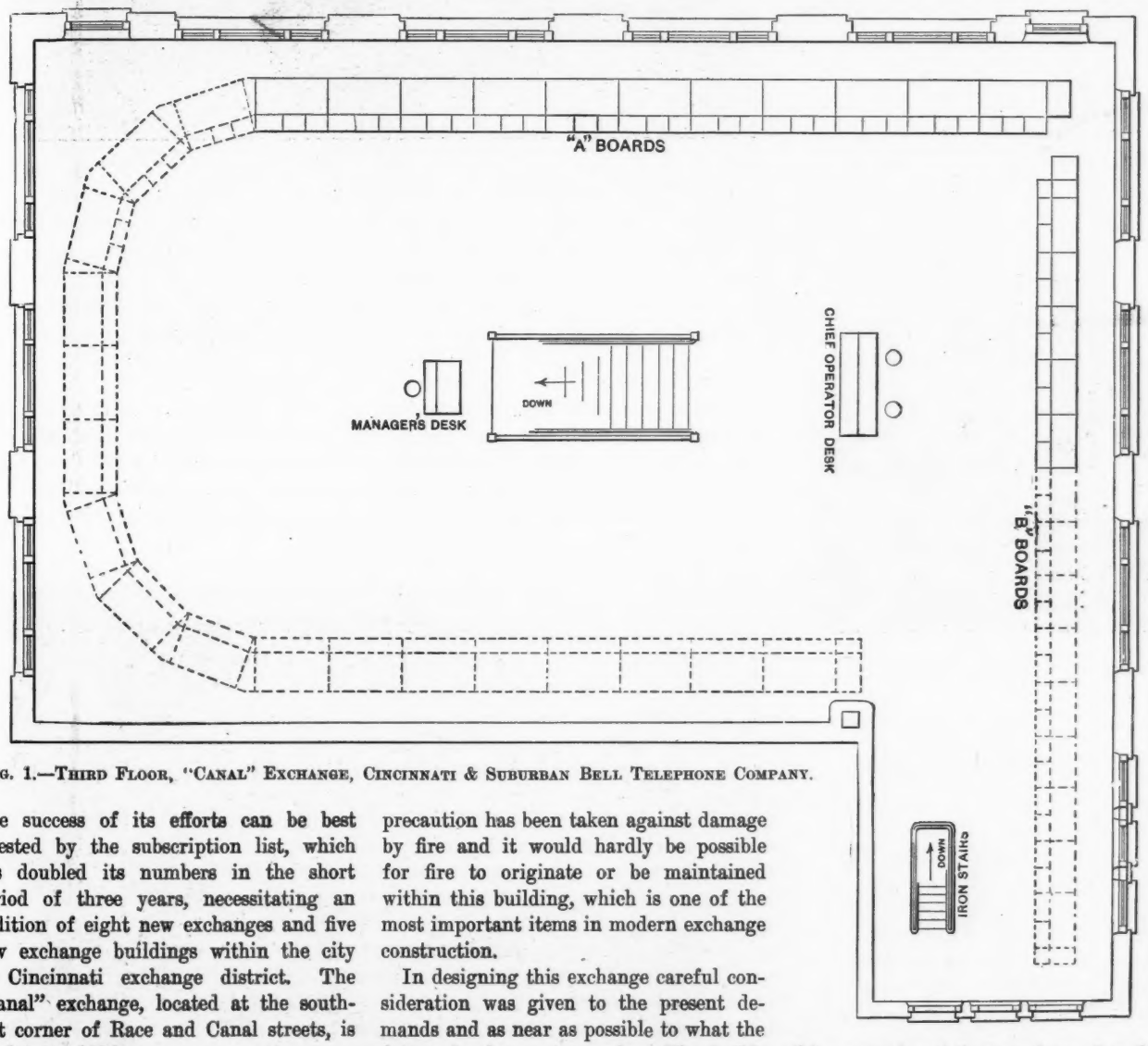


FIG. 1.—THIRD FLOOR, "CANAL" EXCHANGE, CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY.

amount of stir and confusion when making shifts, also all operators are brought directly in contact with the chief operator upon entering or leaving the room.

The second floor contains the operators' quarters and apparatus room—the latter being separated from the operators' quarters by a fireproof wall. The operators' quarters consist of restroom, lunchroom, locker room, kitchen, refrigerator room, janitor's closet and toilet room. The toilet room is finished in white Italian marble with neat mosaic floor; a double row of washbasins have been placed in the centre of the room with a large plate-glass mirror between them. Expanded iron lockers are used in the locker room, and by putting two to a locker there is capacity for 176 operators. The kitchen is equipped with lockers for china and silverware, also an elevator for hoisting provisions and removing garbage. The operators' quarters are in charge of

FIG. 2.—NEW "CANAL" EXCHANGE OF THE CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY.

a matron, who looks after the welfare of the operators while off duty; the company furnishes coffee, tea and sugar free of charge. The apparatus room contains main and intermediate frames, relay rack and repeating coil rack. Entrance to this room is by way of steel staircase, shown in lower right-hand corner of drawing.

The rear section of the ground floor contains the wire chief's and inspectors' quarters. Entrance to this department is on the Canal street side of the building. In the front are two storerooms—one of which is being equipped as a telephone school and lecture room where all new applicants for positions will be examined as to qualification, and taught the best methods of operating before being placed at the regular switchboard. Lectures on operating will also be given here at stated intervals to the regular operators in order to keep them thoroughly posted and ensure the best possible service. There is a double vestibule entrance to the exchange proper. Between the outer and inner vestibule there is a double plate-glass door controlled by speaking tube and electric lock from the chief operator's desk on the third floor in operating room. The outer doors to the street are double plate glass and left unlocked night and day so the public may have access to the automatic pay-station shown in the outer vestibule. Should any one desire to enter the operating department, it is only necessary to press the push-button and communicate with the chief operator through the speaking tube; if the chief operator considers it a proper individual to have admittance, she presses the button upon the desk and unlocks the door which automatically closes behind him on entering. These vestibules are very neat; the walls and ceiling are of white Italian marble and the floors are finished in very neat mosaic designs.

The power room is located in the rear of the basement. The centre of this floor contains the heating apparatus, in the front are two large cellars that are arranged to go with the storerooms on the ground floor above. The building is heated by direct indirect system of hot water heaters; a ventilating system has also been provided for in order to have a perfect circulation of fresh air and ensure comfort and good health to those confined within the building.

Fig. 2 is an exterior view of the building.

FIG. 3.—SUBSCRIBERS' SWITCHBOARD AND CHIEF OPERATOR'S DESK, "CANAL" EXCHANGE, CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY.

FIG. 4.—CHIEF OPERATOR'S DESK, "CANAL" EXCHANGE, CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY.

Fig. 3 is a view of the subscribers' switchboards and chief operator's desk. By the side of the staircase will be seen a Dey time clock, used by the operators

to record their arrival and departure. Fig. 4 gives a clear idea of the equipment and arrangement of the chief operator's desk. This desk contains a card system with sufficient capacity to accommodate 14,000 subscribers. Every device has been supplied that would contribute to giving speedy attention to all of the various duties that devolve upon the chief operator. The cabinet on the floor at the right of the desk contains the electric light and fan switches, which can also be controlled by the chief operator without having to leave the desk.

FIG. 5.—OPERATING ROOM, "CANAL" EXCHANGE, CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY.

This desk was manufactured in the shops of the Cincinnati & Suburban Bell Telephone Company and in service has proven to be the most practicable device so far used by the company.

FIG. 6.—APPARATUS ROOM, "CANAL" EXCHANGE, CINCINNATI & SUBURBAN BELL TELEPHONE COMPANY.

Fig. 5 is another view of the operating room, showing the manager's desk and the staircase entering the operating room.

Fig. 6 is a partial view of the apparatus room showing the main and intermediate frames, also relay rack.

All of the equipment used is of the standard Western Electric type. The power for operating the exchange is supplied by chloride accumulators; to ensure against a possible failure in the battery-charging machine, the company has adopted the system of using one motor-generator set and one duplicate generator belted direct to a gas engine. The gas engines have proven as satisfactory as the motor-generator sets for charging the batteries. The ringing machines are in duplicate and are operated from the storage battery. Every device and arrangement of apparatus has been provided that would ensure against interruption to the service from any source.

Cutting this exchange into service was a very interesting undertaking, from the fact that it was a division of the territory being served by the west and main exchanges. A new exchange centre being established, it required considerable skill and caution to cut the line over without interrupting the service, but the transfer was very successfully executed in a short time. The Cincinnati & Suburban Bell Telephone Company has not been hampered by competition and has done itself proud in giving to Cincinnati and vicinity a very high-grade system of exchanges. While the subscription is increasing at the rate of about five hundred per month, it is in a position to promptly meet any and all demands. The officials of the company are: John Kilgour, president; B. L. Kilgour, general manager; R. T. McComas, assistant general manager; W. A. Blanchard, secretary and treasurer.

ACYCLIC (HOMOPOLAR) DYNAMOS.[1]

BY J. E. NOEGGERATH.

Except for very low pressures, the so-called homopolar dynamo has so far been a failure from a commercial point of view. This failure is principally due to two conditions: first, the uncertainty as to the magnetic and electrical conditions prevailing in this type of generator; secondly, the difficulties encountered in collecting large currents from a generator running at a high rate of speed. These conditions will be discussed in this paper, and in order that their import may be grasped there will be described in outline the design of, and some results obtained with, a 300-kilowatt, 500-volt, turbine-driven acyclic (homopolar) generator built in the shops of one of the large electrical manufacturing companies. The

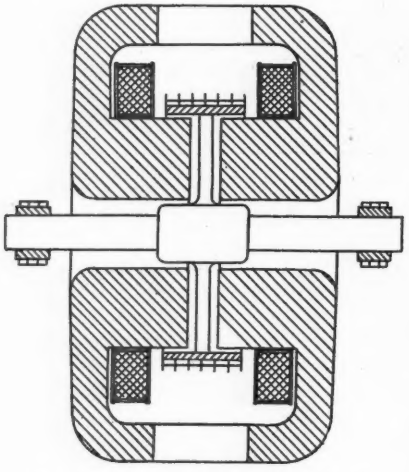


FIG. 1.—RADIAL TYPE; SINGLE DISC.

question dealt with is a broad one, too broad to be discussed at length in this paper; the main points only will be taken up and a more thorough discussion left for a later date.

Classifying acyclic generators according to the position of the armature conductors, we find two prevailing types:

1. The radial type; single disc, Fig. 1; double disc, Fig. 2.

2. The axial type; single cylinder, Fig. 3; double cylinder, Fig. 5.

(The cylinders being solid or hollow—Fig. 4). Combinations of these types are, of course, also practicable.

The armature of the cylinder-type acyclic dynamo here under consideration, Fig. 5, consists chiefly of a solid cast-steel cylinder carrying a small number of straight conductors on its surface; these conductors are connected at both ends to sets of collector rings.

The field, Fig. 5, consists chiefly of a cast-steel structure extending toward the shaft in three polar projections that enclose the armature in complete cylinders. Field coils, F 1 and F 2, are wound concentrically around the shaft.

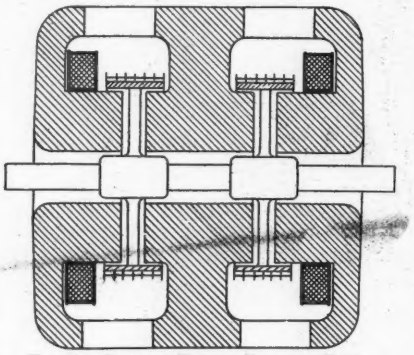


FIG. 2.—RADIAL TYPE; DOUBLE DISC.

There are also mounted two sets of brushes and a number of stationary conductors (frame conductors). Eight openings give access to the brushes and field-spools.

The field-spools set up two primary fluxes shown in Fig. 5 as dotted lines and in Fig. 6 as dotted lines, diverging radially.

As the armature revolves in this uniform field, electromotive forces are generated in the armature conductors, Figs. 5 and 6c; these electromotive forces are constant as to magnitude and direction. Single conductors or groups are connected in series by means of collector rings or

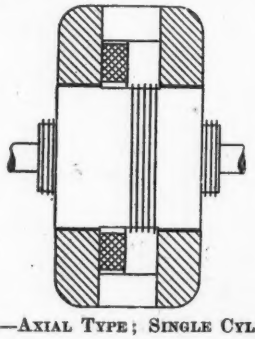


FIG. 3.—AXIAL TYPE; SINGLE CYLINDER.

commutator segments and the frame conductors.

The induced electromotive force

$$= \frac{\phi\ N\ n\ 10^{-8}}{60}$$

$$= 1.66\ \phi\ N\ n\ 10^{-10}$$

Where ϕ = total flux

N = revolutions per minute

n = armature conductors in series.

Fig. 7 shows diagrammatically the simplest form of an electric circuit in a cylinder type of generator, C and R representing armature and frame conductors, C r and B representing collector rings and brushes respectively. The currents passing through this system set up secondary fields which affect the primary flux. Of these, the ones created by the currents flowing in the collector rings (ring reactions) are of great interest from a practical point of view.

For a given time the connection point between armature conductors and collector ring passes through P_1. At this moment currents flow from P_1 to B_1 through both sections of the ring, the currents being inversely proportional to the ohmic resistance of the ring-sections. The currents set up fields in the magnetic material in which they are completely embedded.

As the armature revolves, the connection point P_1 moves on, changing magnitude and direction of the magnetomotive

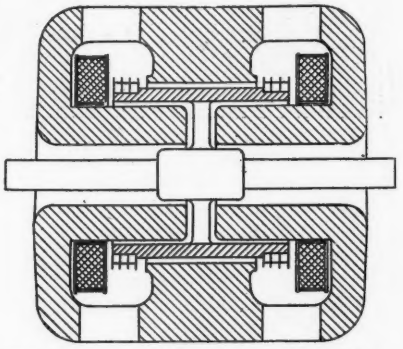


FIG. 4.—AXIAL TYPE; DOUBLE CYLINDER.

force. These periodical changes of magnetization create hysteresis and eddy losses in the solid material. They also weaken the primary flux, since, due to saturation, the increase in density is considerably smaller than the decrease. This means bad regulation.

There are various means of counteracting ring reactions. One consists of placing brushes all around the ring, practically covering its surface. For commercial pressures this method is out of consideration because of the great number of collector rings. It would be impracticable to adjust and watch the very large number of brushes required in this case. The question of friction losses also limits the number of contacts.

Satisfactory results were obtained with a method which is diagrammatically shown in Fig. 8. R_1, R_2, etc., B_1, B_2, etc., and P_1, P_2, etc., represent rings, brushes, and connection points of the collecting system on one side of the armature of one collector. The connection points form

[1] Presented at the 193d meeting of the American Institute of Electrical Engineers, New York, January 27, 1905.

a spiral of one complete turn, while the contact points of the brushes form one or more turns of a spiral running in the opposite direction. The brushes are arranged in groups that can be inspected from the openings in the frame. In this case Σ magnetomotive force $= 0$ for each section of the collector periphery and for any position of the armature.

As to the armature reaction, reference is made to Figs. 5 and 6. The currents flowing in the armature conductors C set up secondary fluxes as indicated by the curved lines. These secondary fluxes cut the frame as the armature revolves, causing hysteresis and eddy losses. They also increase the primary flux at α and decrease it at β. On account of saturation, the weakening effect will again be considerably augmented, affecting the regulation. When the conductors are placed

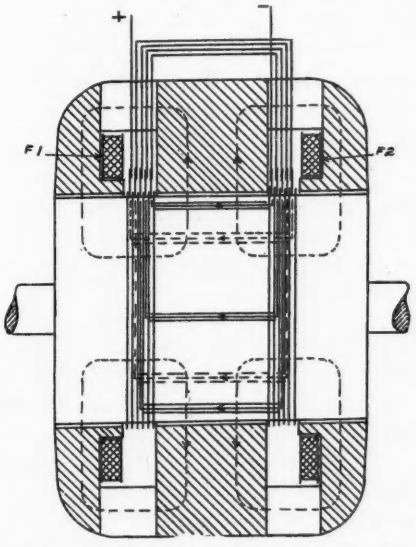


FIG. 5.—ARMATURE OF CYLINDER TYPE, ACYCLIC DYNAMO.

close together, that is, in approaching the equation

$$\frac{d\,i}{d\,l} = C$$

where $i =$ amperes, $l =$ unit length of armature periphery. The radial components of these secondary fluxes at α and β are neutralized. Similar considerations are valid for the stationary conductors.

The most efficient means of conforming to this equation consists of using flat conductors mounted close together. They may be assembled inside of the armature body or on its surface, Fig. 6B. The remaining components of all the local fluxes form one circular field that intersects at right angles with the primary flux, Fig. 6. Considering the influence of these magnetizations upon each other, two conditions are of importance.

1. The medium between armature and frame conductors consists of non-magnetic material, air; that is, the conductors are mounted on the surface of armature and frame respectively, Fig. 9A.

If in Fig. 10, M 1 and B 1 represent magnetomotive force and density of the primary, M_2 B_2 the magnetomotive force

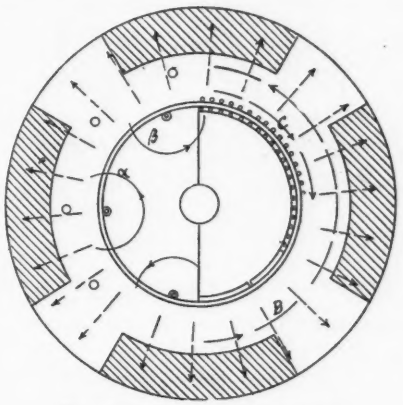


FIG. 6.—FIELD SPOOL FLUXES.

and density of the secondary flux produced by the armature turns, then M_3 B_3 will designate the resulting flux, provided the reluctance is the same in all directions. It is evident that the component of the flux in direction of the primary magnetization remains unchanged.

In an air-gap the length of the path of the resulting flux will actually be somewhat greater than that of the primary flux. But on account of the very high reluctance in the path of the armature reaction, the secondary flux is so small that direction and magnitude of the resulting field do not differ appreciably from the primary.

2. The magnetic medium between the stationary and revolving parts of the winding consists of iron, Fig. 9, B, C; Fig. 11. Principally due to saturation,

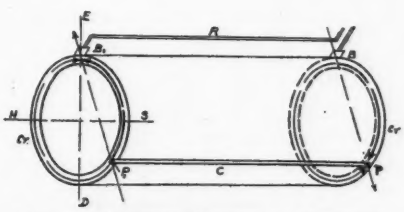


FIG. 7.—ELECTRIC CIRCUIT IN CYLINDER TYPE GENERATOR.

the density of the resulting flux will be considerably smaller than $\sqrt{B_1^2 + B_2^2}$, and its component in direction of the primary magnetization appreciably weaker than B_1. But to restore the flux to its original value only so many ampere-turns have to be added as are required for the increase in density along that part of its path that is affected by the secondary magnetization. The influence of a given armature reaction or regulation is therefore determined by the relation between the reluctance of the primary magnetic circuit in that area and the total primary reluctance. It can be kept very low.

While for the circuits B and C, Fig. 9, the main secondary magnetizations are practically of the same order, the local fluxes produced by the part of circuit C that runs parallel to the shaft are much smaller than in B, because of the high reluctance. They are, in fact, negligible. The neutralization of the ring and armature reactions as discussed above is very complete.

Tests on the 300-kilowatt generator show that the difference in pressure between full load and no load is only slightly higher than the drop, due to the total resistance of the armature circuit; that is, regulation is good.

While the armature windings of acyclic dynamos will not be discussed in detail, yet the points that have to be considered

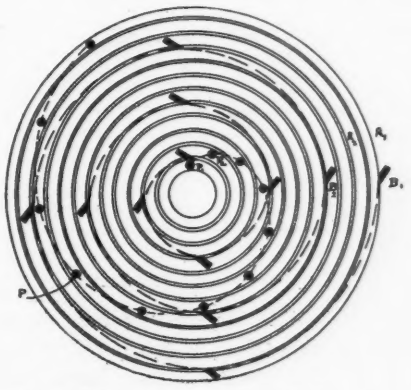


FIG. 8.—COUNTERACTING RING REACTIONS.

in laying out these windings would better be indicated here; they are:

1. Neutralization of ring reactions.
2. Magnetizing effect of end connections.
3. Minimum pressure between rings.
4. Assembling of brushes in groups for accessibility.
5. Equal resistance of armature circuits.
6. Minimum pressure between adjoining conductors.

Point 5 is to be considered if it is desired to run the machines at different pressures, Fig. 16.

Accumulative or differential compounding of acyclic motors or generators can be effected either by means of a series coil, or by giving an angular displacement either between the contacts and the frame conductors or between the connection points and the armature conductors, Fig.

13. For instance, Fig. 12, the currents flowing in the leads that connect the frame conductors and brushes partly or totally enclose the armature. The circular com-

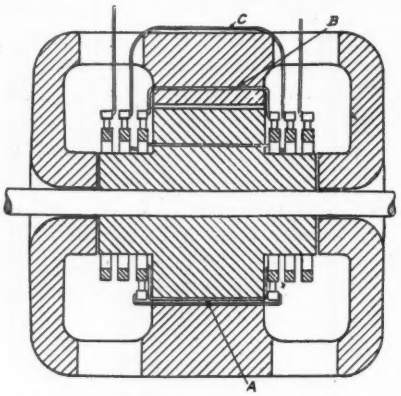


FIG. 9.—MOUNTING OF CONDUCTORS.

ponent of the magnetomotive force of these currents acts in the same or opposite directions as the magnetomotive force of

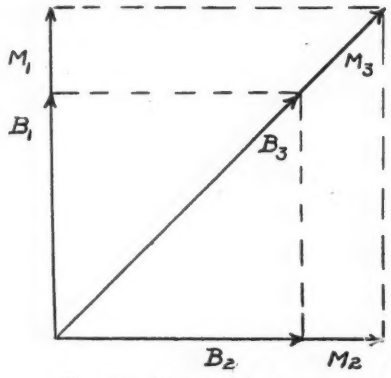


FIG. 10.—DIAGRAM ANALYSIS.

the field-coils. By shifting the brushes it is possible to adjust the compounding. By moving them against the direction of rotation accumulative compounding is

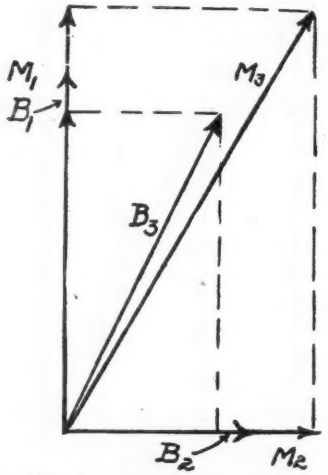


FIG. 11.—DIAGRAM ANALYSIS.

effected in generators; for motors, the result is the reverse.

It is obvious that series generators and motors can be built without field-coils. In such generators the intensity and direction of magnetization can be changed by shifting the brushes and, consequently, the electromotive force of generators as to direction and magnitude can be influenced as well as the speed, torque, and

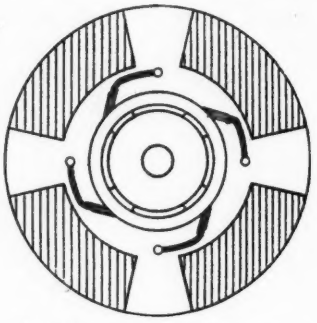


FIG. 12.—CIRCUIT CONDITIONS.

direction of rotation of motors. Acyclic generators are self-exciting.

The considerations of the electrical and magnetic quantities discussed above for an axial type acyclic generator hold good also for the radial type, with the exception of a modification in regard to the

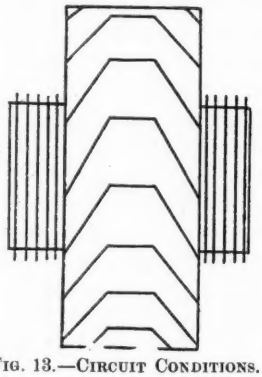


FIG. 13.—CIRCUIT CONDITIONS.

armature reactions. The currents flowing in the armature of the radial type set up fields that enclose the conductors. These secondary magnetizations disturb the primary flux in a way similar to that discussed for the axial type, resulting in core loss and affecting regulation. By placing the conductors close together, that is, in conforming with the equation,

$$\frac{di}{dl} = C$$

the components at α and β are neutralized, leaving a resultant magnetization which may consist of two circular fluxes, F 2, Figs. 14 and 15.

In this case i = current, l^1 = unit length of a circular section taken concentrically around the axis.

The secondary flux F 2 intersects at right angles with the primary. Their influence upon each other can be modified as was discussed for the axial type.

The efficiency of a high-speed acyclic generator about equals that of a turbine-driven commutator generator, but the distribution of the losses is very different.

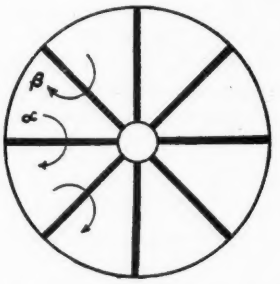


FIG. 14.—CIRCUIT CONDITIONS.

As windage and bearing friction depend on the mechanical design only and not on the type, they can be made to have the same value for both machines.

The I^2R field loss is somewhat smaller in acyclic machines, principally because the length of the air-gap is limited by mechanical requirements and not by the armature reaction.

The I^2R armature loss is almost negligible on account of the small number of turns. In the generator under consideration, there are twelve armature conductors and twelve frame conductors in series.

It is obvious that in a field of uniform and constant density there should be no hysteretic loss. As to eddy currents, reference is made to Fig. 17 where uniform distribution without stray fields is assumed. No electromotive forces are induced in the field. The arrows represent value and direction of the electromotive forces induced in the armature body. It

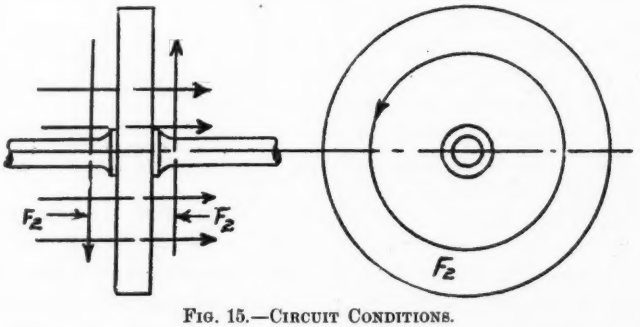


FIG. 15.—CIRCUIT CONDITIONS.

is evident that Σ electromotive force = 0 for any closed circuit inside the armature, as well as in any circuit including armature, bearings and field. From Fig. 18 it will be seen that this is true even if there is a stray field, provided it is uniform.

In general, the distribution of the flux

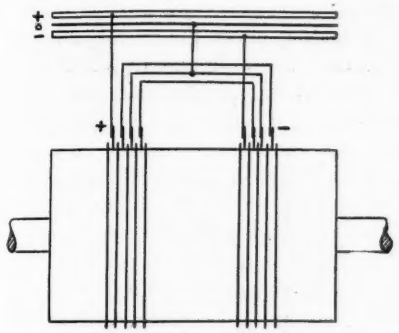


FIG. 16.—VARYING PRESSURES.

in acyclic dynamos that eliminates core loss is expressed by the equation $\frac{d\,B}{d\,L} = C$, where L = unit length of any circle concentric with the axis; that is, the flux

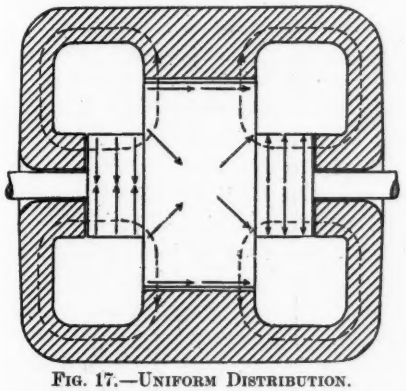


FIG. 17.—UNIFORM DISTRIBUTION.

must have a constant specific linear distribution in the direction of rotation.

The variation of the air-gap length and of permeability, the openings in frame and armature, as well as the secondary fields, disturb this ideal condition. In other words, the flux densities in symmetrical points are not actually equal.

FIG. 18.—EFFECT OF STRAY FIELD.

One-half of this difference in density B *d* represents the B in the hysteresis and eddy current formulas. Its value depends, except on the magnitude of the disturbing elements mentioned above, on the relation of the reluctance in and close to the air-gap to the total reluctance. It is possible to keep this B *d* and, consequently, the core loss very low. The main losses are encountered in the brush contacts.

From a series of investigations the following conclusions are drawn:

1. As to Speed. Fig. 19—There is a steady but small increase of pressure drop at the brush-contacts with increasing speed. The friction loss, declining somewhat, practically remains constant for high velocity. The total losses also remain practically constant above these speeds. The improved ventilation inherent to greater velocity allows a higher current capacity to be used in the collecting system.

2. Current Density—While the relation between current and pressure drop in stationary contacts of metal brushes and metal rings is similar to that in a solid resistance, the conditions in moving contacts are of the character of those prevailing in an electric arc, the apparent resistance falling off rapidly with increasing densities, Fig. 20. The similarity is furthermore illustrated by the fact that in frequent instances, pressures ten to twenty times higher than normal were required to start the flow of current.

3. Brush Pressure—The increase of brush pressure does not decrease the drop

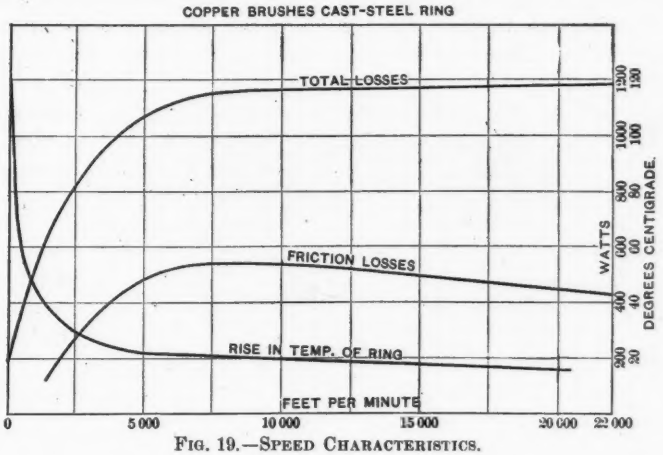


FIG. 19.—SPEED CHARACTERISTICS.

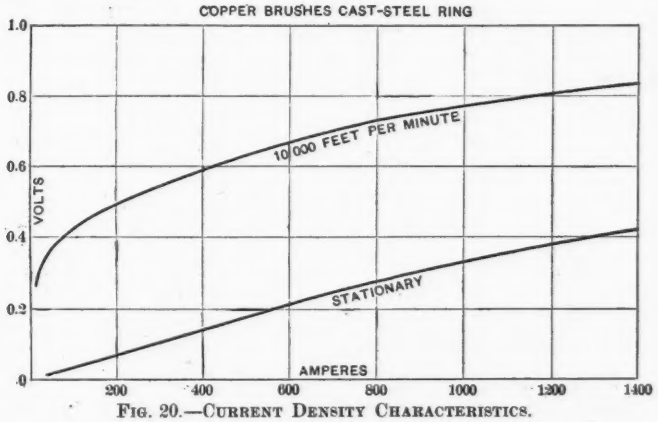


FIG. 20.—CURRENT DENSITY CHARACTERISTICS.

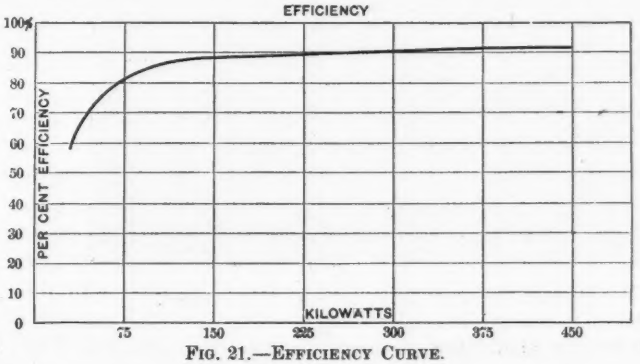
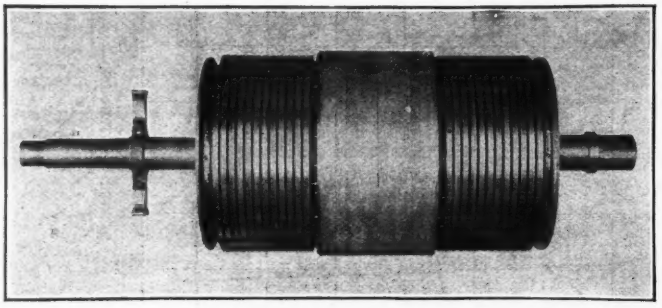


FIG. 21.—EFFICIENCY CURVE.

considerably, but the sparking tendency at high speeds and densities necessitates high pressures.

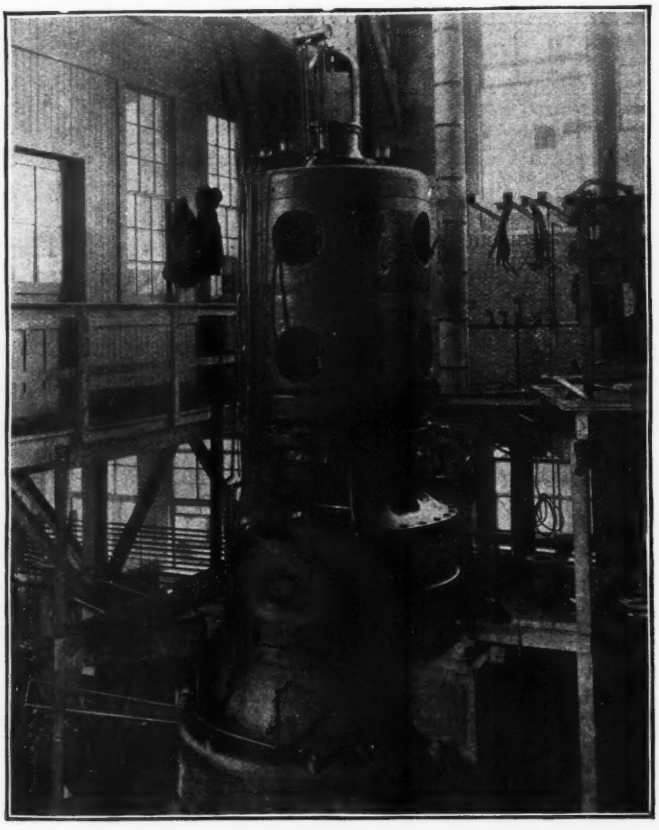
In the 300-kilowatt, 500-volt turbo-generator, the full-load losses equaled twenty-eight kilowatts without windage and bearing friction. The efficiency curve, Fig. 21, is flat, due to the small core and brush friction loss. Regulation equals six to twelve per cent.



Armature and Collector Rings of Acyclic Dynamo.

Considering now the mechanical design, as mentioned above, the generator consists chiefly of a cast-steel armature and a cast-steel frame. On the smooth armature surface twenty-four conductors are mounted, flat sheets bent on the radius of the periphery. The torque is taken up by lugs projecting axially from the armature body and the centrifugal stress by means of steel binding wire.

The twelve collector rings on either side of the armature are assembled close together and mounted on a shell. Eight large-size openings in the frame give access to three brushes each, making a total of twenty-four contacts. The main objection raised against a large number of rings in series is based on the assumption that, consequently many brushes are required, rendering inspection difficult. It seems that twenty-four contacts would be a moderate figure even for a commutator machine of that rating. The stationary circuit consists of twelve cables. Without interfering with other parts, the armature or the stationary winding and either set of collector rings may be removed.



Acyclic Dynamo, Turbine Type, Under Construction.

In comparing commutator and acyclic direct-current machines as to inherent conditions from a commercial point of view, the latter is essentially a high-speed machine, its field being limited in general to large turbo generators, high-speed motors, direct-connected to rotary pumps and blowers and motor-generators.

While the total weights of both types are about equal, even for moderate turbine speeds, the very low copper weight, simple construction—less labor and smaller total cost—combined with the elimination of commutating problems, should speak favorably for the new type.

Electricity and Bread.

The following appeared in the *Kölnische Zeitung* on November 29, 1904, and was transmitted by United States Consul Bartleman from Seville, Spain:

"The power of the electric current to decompose certain substances in a singular way has led to an important development of electrochemistry. In this connection experiments have recently been made in Paris, seeking an improvement in bread-making.

"Laboring under the mistaken impression that the whiteness of wheat bread determines its quality—that the whiter the bread the better—the Parisian public has for years been growing more and more exacting on this score, consequently the fineness of grain flour has been gradually approaching a limit. The public has, as a consequence, received a less nutritive food, it being a known fact that the core of the wheat grain, which is the chief constituent of bread, while producing the whitest flour, at the same time contains the smallest amount of albumen and is thus least nutritious.

"There has recently been raised the hope of obtaining a whiter bread by aid of electricity, for which purpose the flour was brought in contact with electrified air, whose ozone possesses efficacious bleaching properties. A report to the Academy of Science at Paris on the result of an experiment with flour treated in both the ordinary way and by electricity, under similar conditions, explains that the flour subjected to electric influence was much whiter in color, but that its taste and odor were far inferior to those of flour treated by the ordinary method. The amount of phosphorus was the same in both, but the quantities of fatty and acid substances varied largely. Thus, in flour treated by electricity the fatty substances proved rancid, glutinous, and of a less yellowish color, and instead of retaining their usual aromatic yellow state, became oxidized and partly converted into white sebacic acid, which could be dissolved in alcohol. The glutinous substances were discolored and changed.

"The bread made from this flour was whiter than usual, but of inferior taste, and the experiment serves to demonstrate that electric treatment, while successfully turning flour whiter, injures it."

South Dakota Telephone Association Officers.

The South Dakota Telephone Association has elected the following officers: president, C. B. Kennedy, Canton; vice-president, J. A. Steninger, Parker; secretary, H. B. Hartwell, Irene. It has been decided to hold the next annual convention in Sioux Falls, S. D., on the second Wednesday in January, 1906.

THE INTERNAL COMBUSTION ENGINE.[1]

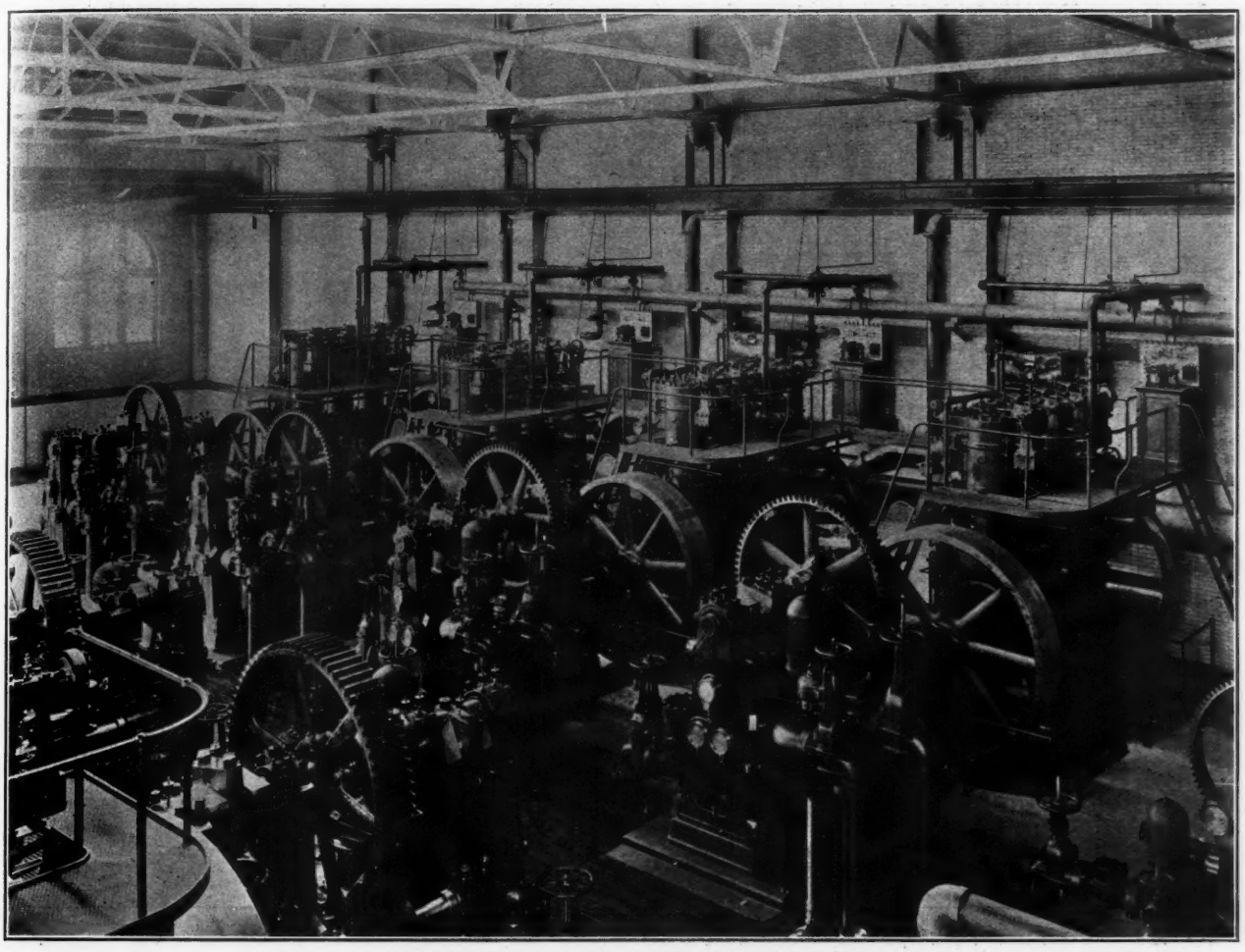
BY J. R. BIBBINS.

ITS PRINCIPLES AND USES.

Of the several prime movers available for general power purposes, which has the highest practical efficiency?

This question is a very pertinent one at the present time; what answer shall we make to it? We search through our stock of information regarding the hydraulic turbine, the impulse type water-wheel, the steam engine, the steam turbine, the gas engine and other motors of specialized character such as the hot-air engine, the sulphur-dioxide engine, the aermotor, the wave motor and the solar engine. At the outset, however, we find it necessary to define clearly the term "practical" efficiency, and we arrive at the conclusion that the true efficiency is represented by the ratio $\frac{\text{useful work done}}{\text{energy input.}}$ Upon this basis, our finding is that the hydraulic turbine motor occupies the most prominent position in the scale of efficiency, approximating eighty-five per cent for either pressure or impulse types. But as the application of the hydraulic motor is entirely restricted by local conditions of water supply, it is practically debarred from general consideration; likewise wind and wave motors. There now remain the heat motors and out of these we find but three which bear the stamp of unquestionable practical success—the steam engine, the steam turbine, and the internal combustion engine.

Recent reports of steam-engine tests show that an indicated-horse-power can be delivered to the piston with an energy consumption of 220 to 250 heat units per minute or 13,200 to 15,000 per hour. By the first law of thermodynamics, which teaches us that heat energy and mechanical energy are mutually convertible, we may reduce the work done by the engine to a heat basis. Joule, and later Rowland, found that one heat unit is equivalent to about 778 foot-pounds. Therefore, the equivalent of one horse-power of work is $\frac{60 \times 33{,}000}{778} = 2{,}545$ heat units per hour. The indicated efficiency of the steam engine is therefore $\frac{2{,}545}{13{,}200} = 19.3$ per cent. Even this efficiency is high and can only be attained by engines of several hundred horse-power capacity working under steam of at least 150 pounds pressure and a good vacuum (twenty-six inches of mercury). In a few highly economical pumping plants a slightly greater efficiency has been reached. Twenty per cent may be considered the limit, and this only with an engine of extreme complexity, great bulk and costly construction. The steam turbine has exceeded this efficiency by a few per cent and its average efficiency may be taken as twenty per cent, based upon useful power delivered to the shaft. But the heat consumption of the ordinary power plant engine may be considered to approximate nearer ten per cent than



HIGH-PRESSURE FIRE-PUMPING STATION, PHILADELPHIA, PA. WESTINGHOUSE VERTICAL GAS ENGINE, DIRECT-CONNECTED TO DEANE PUMPS, SUPPLYING WATER TO UNDERGROUND MAINS AT A PRESSURE OF 300 POUNDS PER SQUARE INCH.

[1] Abstract of a paper read before the Modern Science Club, Brooklyn, N. Y., January 10, 1905

twenty per cent. Hence, in the case of the average engine, eighty to ninety per cent of the heat delivered is lost during conversion into work.

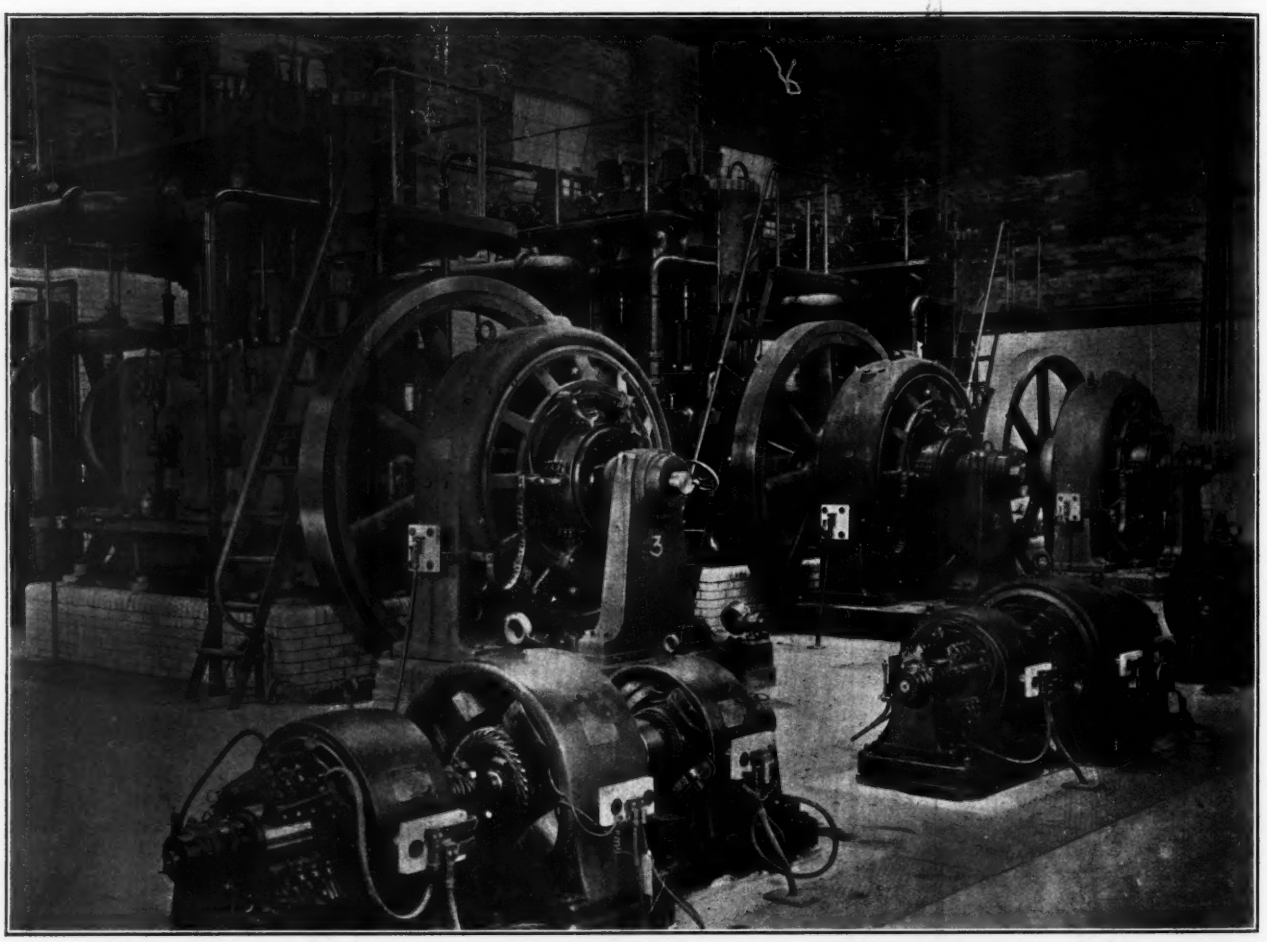
On the other hand, what has the internal combustion engine done to reduce this great loss in heat? Fortunately we are in possession of much data which prove conclusively that a horse-power can be delivered to the shaft of a well built gas engine with an expenditure of 167 heat units per minute or 10,000 per hour. If indicated-horse-power were taken as the basis of comparison, the heat consumption is still less, perhaps 9,000 heat units per hour, and the efficiency is thus $\frac{2,545}{9,000}$ or 28.25 per cent, which is forty per cent higher than the best steam engine. Moreover, this is a very average efficiency of high-grade engines and tests are on record where thirty-four per cent has been obtained.

But, you will ask, if the combustion engine is so highly efficient why has it not entirely displaced the steam engine. There are two reasons, neither of which can be laid at its door as a functionary shortcoming:

First, on account of its high efficiency its early applications have been logically centered in those sections where the cost of fuel was high. Some of the more conspicuous installations in domestic territory are therefore to be found in remote sections such as Southwest Mexico and South America, where coal costs from six to twelve dollars a ton. In Europe, where this type of engine is now used to an extent unappreciated in this country, the extremely high cost of fuel has furnished the main incentive toward its development. Further, by reason of the smaller earning capacity of European properties and the consequent necessity of utmost curtailment of expenses, its high economy has been an important factor in bringing about its general introduction. In America, the general industrial conditions have been distinctly reversed; coal has been abundant and cheap, labor the opposite. And it is thus that the merits of the combustion engine have not been brought home to us with such direct forcefulness. With plentiful stores of energy at hand, previously bottled up by nature for our uses, we have not been in need, until recent years, of the more efficient prime mover.

Secondly, after the introduction of the gas engine had been begun by a handful of enterprising American manufacturers, serious difficulty arose in the provision of a proper fuel. In sections where natural gas was plentiful the difficulty was solved, and the numerous power plants are now running upon natural gas drawn from private wells or from those of a distributing company. In other districts, however, illuminating gas or producer gas has been the only alternative. The former is far too expensive for general power use; the latter has been generally successful only when produced from anthracite coal. Up to the present time a simple and satisfactory bituminous producer has not been put on the market, and this constitutes a serious problem in present and future application of gas power.

As an exception to the above may be mentioned the Mond ammonia recovery



A Model Gas Power Plant, Using Producer Gas. Midland Railway, Hegshaw Harbor. Westinghouse Vertical, Three-Cylinder Engine and Mond Producers.

process, in which bituminous coal is used successfully, large quantities of ammonia being reclaimed in the form of ammonium sulphate. The chemical process, however, adds complication to an otherwise simple system, and is hardly applicable to general development of small powers. There is now under construction in England a large gas distribution system which will supply Mond gas in great quantities to all towns in the south Staffordshire district within a limiting area of 123 miles.

There are several builders in this country and numerous ones abroad who are ready to construct engines up to several thousand horse-power capacity, but they must be supplied with producer gas and this gas must be made from bituminous coal by a process embodying the essential requirements of extreme simplicity and economy. When such a process is available, another revolution in choice of prime movers is certain.

NEW FIELDS.

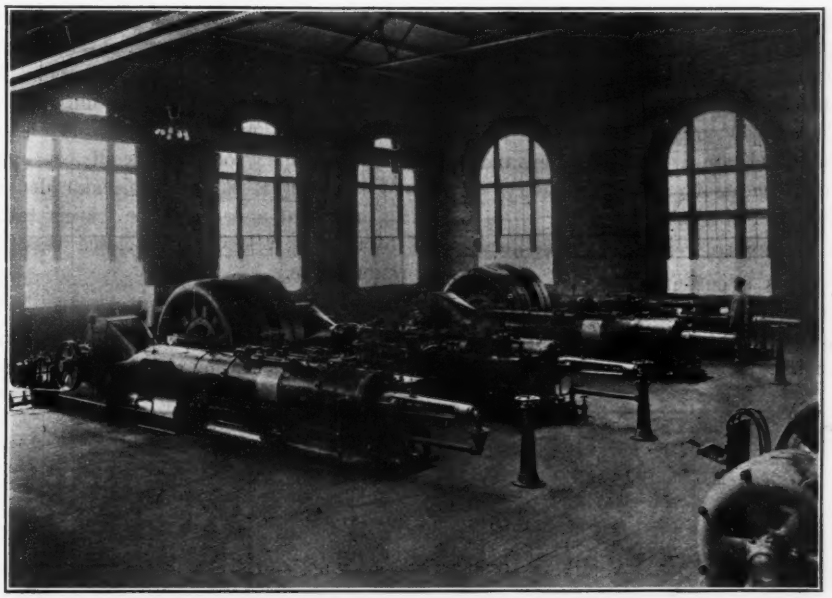
Probably the most important development and achievement in recent gas power engineering has been the conservation of waste gaseous products from blast furnaces, coke ovens, etc. The gas engine is now being rapidly applied with much success to the generation of power from blast-furnace gas. The practice was started in Germany and has now been adopted in America. The money value of this waste gas which is now discharged in the atmosphere as a waste product runs up into fabulous figures. The last United States census on manufacture states that the use of this gas for power "returns a profit" of $1.25 per ton of pig iron produced; or about $150,000 per year for every furnace in the country.

Another and practically undeveloped field for the gas engine is the generation of power from the rich gases given off in the process of coke-making. These gases, like blast-furnace gas, have heretofore been discharged into the atmosphere, transforming the neighboring districts into a state of semi-volcanic desolation. A number of by-product coke processes is now in use including the Semet-Solvay, Otto Hoffman, Lowe and others, in which the coke-making process is so controlled and modified that the rich volatile hydrocarbon gases may be conserved for the generation of power, metallurgical or other purposes.

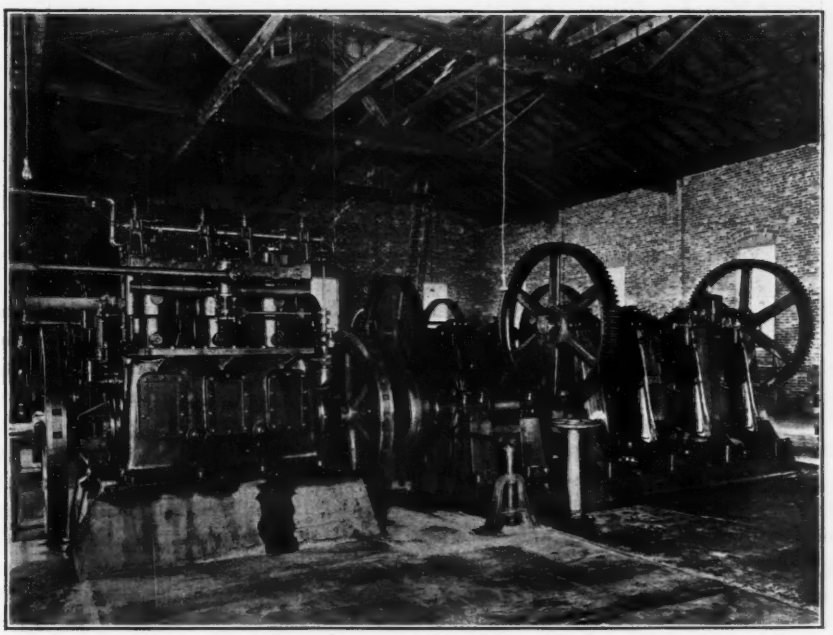
In one notable instance of a large American oil refinery, the rich gases given off during the refinement of crude petroleum are similarly conserved for use in gas engines to generate electricity for light and power throughout the works.

An even more noteworthy development of recent years in the utilization of waste products is the reclamation, or, more properly, destruction of city refuse. Several large plants in Europe generate steam for municipal lighting by burning the combustible refuse under boilers. In Glasgow sufficient heat is thus available to furnish 9,000 horse-power per ten-hour day for manufacturing purposes. It has lately been proposed to modify this process by cremating within specially constructed destructor cells, which are virtually gas producers and operated as such. The resulting gases, after being fixed and enriched if too impure, are then available for conversion into electric power by gas engines.

Outside of these special applications, however, the gas engine has rapidly increased its foothold in all branches of power work, particularly in the generation of electricity for light and power in central stations, isolated plants and industrial works. An eminent English authority, Mr. H. A. Humphrey, estimated at the close of 1902 that there were in operation or had been built engines aggregat-



TYPICAL MODERN GAS POWER PLANT, ATLANTIC REFINING COMPANY, PHILADELPHIA, PA. WESTINGHOUSE TWIN-TANDEM, DOUBLE-ACTING GAS ENGINE, DRIVING ALTERNATORS IN PARALLEL. OPERATE ON WASTE OIL GAS FROM THE REFINERY.



PUMPING PLANT, FORD CITY, PA., PLATE GLASS COMPANY. OPERATE EXCLUSIVELY ON NATURAL GAS, FURNISHING ENTIRE WATER SUPPLY FOR PLATE GLASS WORKS.

ing 182,000-horse-power capacity. This estimate excluded all engines under 200 horse-power, and the average was about 550 horse-power per engine. Conservative estimates would now nearly double these figures. A number of engines of 1,000 to 1,500 horse-power had then been built; to-day engine capacities up to 4,000 horse-power are under construction and still larger sizes will be contracted for on demand by responsible builders. These facts indicate a tremendous advancement in a comparatively new industry—barely a quarter of a century old.

EXPLOSION VS. COMBUSTION.

It is a curious fact that in spite of evidence to the contrary the gas engine is generally considered as an explosion engine. We are all acquainted with the power of dynamite, gun-cotton, and other explosives to instantaneously resolve themselves into gas when ignited by a detonator; yet these substances will burn rapidly but without explosion when ignited in the ordinary manner. With best mixture the period of the so-called explosion was one-thirtieth of a second, but with poorer mixture the full pressure was not reached until nearly one-half second had elapsed. Further, the highest pressure obtainable without previous compression was ninety-six pounds per square inch. Does this savor of explosive suddenness of violence, as these terms are used in their true sense?

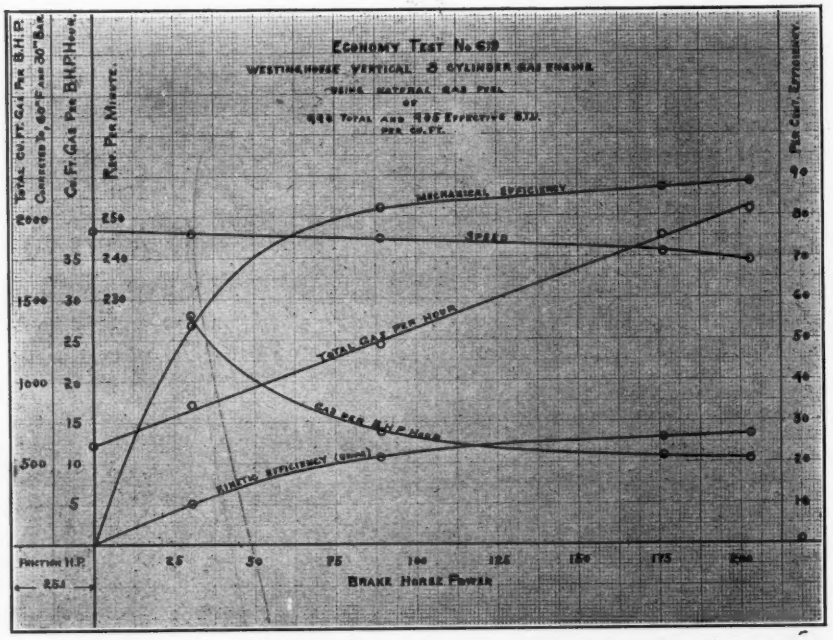
The gas engine is thus not a true explosion engine, although high pressure and rapid combustion take place due to the small volume at ignition and the large quantity of heat energy contained. The rate of flame propagation or flame advance through an unconfined combustible mixture is a perfectly definite quantity—about one metre or three and one-fourth feet per second for coal gas. With true explosion this rate is over 1,000 metres or 9,000 feet per second, as stated by Dugald Clerk, for a perfect mixture of oxygen with hydrogen, which is one of the principal constituents of coal gas. When compressed, the molecular density is increased and the flame travels faster so that its velocity in a closed vessel is cumulative.

PERFORMANCE UNDER TEST.

In accurately determining fuel economy the indicator has, by almost common consent, been discarded in favor of the Prony or friction brake, owing to the difficulties in the calibration and use of the indicator with the sudden and excessive pressures encountered. The brake test involves the actual work delivered by the engine at the shaft. It is therefore free from the uncertainties attached to indicated performances. By measuring the quantity of gas delivered to the engine by meter, and its calorific value by one of the several forms of gas calorimeters, the actual heat consumption of the engine is readily determined.

A typical test is shown, taken at random from nearly a thousand tests on individual engines that have been constructed at East Pittsburg. The curve of total gas consumption is very nearly a straight line throughout the range of normal engine capacity. This furnishes ample evidence that the engine consumes heat in gaseous form with the same inherent efficiency at all loads. This characteristic ensures a continually decreasing gas consumption per horse-power as the load increases, reaching the maximum at about full load, as shown by the curve. At this point this engine consumed ten and three-fourths cubic feet of natural gas per horse-power, equivalent to 9,800 effective British thermal units per brake-horse-power-hour, or 163 British thermal units per minute. This corresponds to a thermal efficiency of nearly twenty-six per cent.

The efficiency of a gas engine is but very slightly affected by the kind of gas used, provided that the mixture of gas and air is of the proper proportion, and it is found that the gas consumption in cubic feet varies in practically inverse proportion to the heat units obtained. Thus, if an engine consumes ten cubic feet of natural gas containing 1,000 British thermal units per cubic foot, it will consume about thirty cubic feet of coal gas containing 350 British thermal units, eighty cubic feet of producer gas of 125 British thermal unit heat value, and 105 cubic feet of blast-furnace gas containing ninety British thermal units per cubic foot. With the lesser gases a higher compression may be carried without risk of spontaneous ignition or back-firing, thus conducing to higher economy which is, of course, due to the increase in pressure and temperature head thus made possible.



VERTICAL THREE-CYLINDER GAS ENGINE UNDER TEST, USING NATURAL GAS.

The Amsterdam-Haarlem Tramway System.

The British electrical papers published recently descriptions of the Amsterdam-Haarlem electric tramway system, which has just been completed by J. G. White & Company, Limited, of London. Haarlem and Amsterdam are only ten miles apart, and the plan of connecting them by means of an electric road is not a new one. Some years ago a route was laid out, but it was too roundabout and the scheme was abandoned. In 1901 a concession was granted by the Holland government for the construction of an electric system parallel with the steam railway. The conditions, however, were stringent. The company was required to sheet-pile the sides of the road, which is bordered on one side by a canal, and on the other side by a ditch, in order to secure the necessary width and stability, and to carry out the whole of the work with the least possible interference with the regular use of the road. The concession is for a period of fifty years. It was required that plans for all work be approved by the government, and two years were allowed for carrying out the construction. The secretary of state fixes the maximum speed allowable and the maximum rate

which may be charged. At the expiration of the concession the government will take over, without compensation, all property located on government land.

To enter Amsterdam a private right of way was secured for about two miles from the government road to the city limits. Within the city the right to run over the existing system was secured. The strip of land secured was wide enough to permit of a row of building lots being laid out on either side. On this section the track is built in the centre of the road; along the highway it is located on the sides of the road, with a driveway between the tracks.

In addition to the piling, a good deal of other construction and reconstruction was necessary. A large swing bridge was required, and a third rail had to be laid within Amsterdam, since the system there uses the standard gauge, while the new road has a gauge of one metre.

The power-house is located on the canal bank at Halfweg, a village midway between Amsterdam and Haarlem. The location is good, not only for the feeder system, but for securing coal and water. Owing to the nature of the country, the condition of the ground at that point was poor, and an elaborate system of piling was necessary, the entire site being piled with forty-six-foot long, nine and three-quarter-inch diameter piles, placed four feet one inch apart. The building itself is of brick with stone trimmings, and covers an area of something over 9,000 square feet. The main generating plant consists of three Belliss self-lubricating, three-crank, enclosed, triple-expansion engines, each rated at 430 brake-horse-power. The steam consumption is thirteen and one-half pounds per brake-horse-power-hour, superheated, and seventeen pounds with saturated steam, when operating with a twenty-six-inch vacuum. The speed is 375 revolutions per minute. The generators, furnished by the Societe Anonyme Westinghouse, of Le Havre, are direct-connected and rated at 300 kilowatts, 525 to 575 volts. The foundations for the main engine and condensers were built of concrete. Surrounding the engine and condenser foundations are arches of concrete to support the engine-room floor.

There are thirty-four cars, each divided into two compartments, the largest seating twenty-two passengers, and the other twelve. The cars are provided with hand-brakes and air-brakes, and are equipped with fifty-horse-power motors.

On that part of the road from Haarlem to Zandvoort bay, contact is made with two wires simultaneously. The trolley wire is zigzagged in order to equalize the wear on the bow. Through the village of Halfweg there are two sections of single line, which are protected by an automatic electric signaling device. When a car enters either of these sections the collecting bow makes contact, closing an electric circuit and lighting the signal lamp.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

READING AND DISCUSSION OF TWO INTERESTING PAPERS.

The 193d meeting of the American Institute of Electrical Engineers was held on Friday evening, January 27, at Carnegie Hall, New York city. The meeting was opened by President J. W. Lieb, Jr., who spoke of the sudden death of Mr. E. H. Mullin, and the loss to the Institute in consequence. The death of Mr. C. M. Wilkes, of Chicago, was also announced.

The first paper of the evening was then read by Mr. J. E. Noeggerath, of Schenectady, N. Y. It was entitled "Acyclic (Homopolar) Dynamos," and described a 300-kilowatt, 500-volt, turbine-driven acyclic generator which has been built by the General Electric Company and tested in its shops. This paper will be found on another page of this issue. Mr. Noeggerath first discussed briefly the theory of such machines, classified them according relatively to the direction of rotation and that of the electromotive force produced. He explained the armature reactions, showing how they could be controlled and how the machine might be compounded. The results of tests which were given show that the friction losses are the most important. The efficiency was found to be high, being over ninety per cent at full load. The regulation is between six and twelve per cent, according to the density of the magnetic flux and the arrangement of the conductors. The weights of this machine are about the same as those of turbine-driven, direct-current dynamos. They, cost, however, much less, and only fifty per cent of the copper is required. These conditions obtain only at and above 300 kilowatts; for smaller machines the type is not favorable.

The discussion was opened by Professor F. B. Crocker, of New York, who referred to the paper read by himself before the Institute in 1894, describing unipolar dynamos, as they were then called. The machine is really a Faraday disc machine, and, in fact, Faraday had proposed increasing the electromotive force by multiplying the number of discs. Professor Crocker objected to the designation of the different types of machine as "radial" and "axial," holding that the terms in general use, "disc" and "cylinder," were more appropriate. He called attention to the high electromotive force per foot of conductor, which, assuming the speed to be 12,000 feet per minute, and the magnetic flux 90,000 lines per square inch, was twenty-six volts per foot. The armature reaction corresponds to that of a direct-current machine with no brush lead—that is to say, it is a cross-flux. One of the interesting points in the construction was the compounding effect which could be brought about by simply shifting the brushes. Professor Crocker thought that blow-holes in the magnetic parts would be the cause of eddy currents.

Dr. W. E. Goldsborough, New York city, dwelt upon the importance of machines of this type in certain classes of work. He said that many engineers had tried to develop a satisfactory homopolar machine, but so far this seems to have been the only successful one.

Dr. A. E. Kennelly, Cambridge, Mass., said that this was one field in which the direct-current machine has an advantage over the alternating-current. As there is no need to laminate any part of the iron-work, the field and armature cores can be cast. The enormous speeds give high electromotive forces, and should reduce the weight of the active part after all allowance had been made for material used simply for mechanical strength. An interesting point was the size of the collector rings or commutators, this being practically twice that of the armature surface.

Mr. Crellin Cartwright, of Schenectady, N. Y., pointed out the advantages of this class of machine for carrying overload. There is no trouble with the collecting brushes, due to overloading, and the insulating material is designed more particularly for mechanical than dielectric strength—hence the machine should be very important for railway work.

Replying to this discussion, Mr. Noeggerath held that classifying machines as "cylindrical" and "discs" is not satisfactory, since a cylindrical machine may have an electromotive force developed in it radially. He pointed out the difference between the armature reaction of the acyclic dynamo and that of a direct-current machine. In the latter the cross-magnetization causes crowding of the flux at one pole tip, and a weakening at the other. In the acyclic machine there is no such crowding, but a true composition of flux takes place. He did not think that blow-holes would produce the losses anticipated. In fact, he had drilled holes through a machine to secure better ventilation without any perceptible increase in the iron losses. The collector rings used are ordinary hard cast steel, not hardened. Of course, nickel steel would

be better. So far the brush-wear on this machine had not proved to be excessive.

President Lieb then introduced the second paper of the evening, which was by Mr. J. E. Moultrop, entitled "Modern Central Station Design as Exemplified in the New Turbo-Generator Station of the Edison Electric Illuminating Company of Boston." It consisted of a discussion of this station, which has already been fully described in the ELECTRICAL REVIEW of May 21, 1904, and was read by the author. In calling attention to the importance of design, President Lieb quoted figures from the United States census for 1902. He pointed out that in one of the largest New York central stations ten per cent of the power equipment is in use only twenty-five hours during the year, and all of this occurs within one month; twenty-five per cent of the station equipment is used only seventy-five hours during the year, all occurring within two months, and fifty per cent of the equipment is in use only 500 hours, all within seven months. These features have a great influence on the design of the station, and should always be borne in mind.

The discussion was opened by Mr. H. G. Stott, New York city, who spoke of the relation of the cost of generating plants to the operating cost. He showed that an extra investment of $12.50 increased the cost per kilowatt-hour one-half cent. Many plants cost too much to be economical, as the interest and depreciation equal the operating cost. It would be better in many cases to put in a less economical, but cheaper plant. He thought that the steam turbine is a move in the right direction, in that it reduces the first cost of the station.

As has been pointed out, a good part of the machinery is needed to carry the peaks of the load, but as these exist for a short time only, there is no need that the machines should be operated with high economy when carrying them. What should be done would be to demand generators with a great overload capacity, but they need not be efficient at these loads. This would bring down the interest and depreciation. Mr. Stott did not think it was safe to have no cross-connections in a station, as is true in Boston. He thought this applied particularly to the steam piping. He pointed out that banking boilers when using mechanical stokers requires almost as much coal as running the plant during the lighting hours, and if there were cross-connections in the steam piping, a new generating unit could be started, using the boiler equipment intended for the one which was being taken out of service; hence banking one set of boilers would be avoided. Mr. Stott would not admit that a steam turbine could be put into service more quickly than a reciprocating engine. He said that barometric condensers could be introduced in a station, giving equally high vacuum, and yet costing six cents per kilowatt less, which was equivalent to one-quarter of a cent less per kilowatt-hour.

Mr. F. C. Bates, quoting some figures given by Mr. W. L. Emmet, said that a 5,000-kilowatt generator, located in a city plant, would, during a year, use $6,000 worth of city water. Using surface condensers ninety per cent of this could be saved. Capitalizing the $5,400 thus saved at ten per cent showed that the surface condensers were equivalent to a saving of $54,000. Putting it another way, the saving would be equivalent to two pounds of steam per kilowatt-hour.

Mr. Philip Torchio, New York city, agreed with Mr. Stott in regard to the drawbacks of complete separation of the operating machinery. He did not think it advisable to remove the switchboard operator from the engine room. An experienced operator depends almost as much upon his ears as his eyes for detecting trouble. Placing him in a separate room deprived him of any audible warning. He thought that a reciprocating engine could be thrown into service more quickly than a turbine. As the high economy of the steam turbine is due to the high ratio of expansion of the steam, it is essential that a high vacuum should be maintained; hence surface condensers are necessary. He called attention to the fact that European engineers have had a good deal more experience with turbine performance than we have had in this country. This experience has so far been satisfactory. In one particular case a turbine case had been sealed up and then run for 17,000 hours without examination. At the end of this period it was opened in the presence of a delegation, and showed no corrosion whatever, either of wheel, blades or nozzles. He thought that if a station were well designed it was fair to assume that it should produce one kilowatt-hour per sixteen pounds of steam, using 150 degrees superheat.

Mr. C. O. Mailloux, New York city, also compared European station design with that of this country. He was pleased to see more attention being given to the finish of the station, as this was undoubtedly a move in the right direction. He held that a surface condenser would give a better vacuum than a jet condenser, and said that in Europe vacua are not as high as in this country, twenty-six or twenty-seven inches being considered good practice there.

Mr. W. F. White, of New York, said that surface condensers enable boilers to be run a longer time without being cleaned. He thought that too little attention is being paid to carrying a suitable coal reserve. It is impossible to store a satisfactory reserve in overhead bunkers, as these would become so large as to make the cost of the building excessive. This being the case, a storage yard is necessary; and, having a storage yard, it becomes unnecessary to install large bunkers in the building.

Mr. Stott, taking up again the subject of jet condensers, said that there are now in operation in New York sixteen barometric condensers, which, without the use of dry air-pumps, give eighteen inches vacuum. When a dry air-pump is employed, they give twenty-nine and one-quarter inches; within one inch of the absolute vacuum. He called attention to the losses taking place when coal is stored outside. Twenty-five per cent of the heat value is lost very quickly. Mr. Stott said that it is incorrect to assume that the use of surface condensers enabled water to be used over and over again in boilers, as distilled water has a corrosive effect upon the boiler tubes and on the superheaters. He mentioned a particular case in which a reciprocating engine had been started up and thrown into synchronism in one minute and thirty-seven seconds.

Replying to the discussion, Mr. Moultrop said that it is very true that many large plants to-day are too good. He did not think this applied to the Boston Edison company's plant, because this is the result of the growth of a large system. Everything being considered, the tile finish will be cheaper in the end. The new plant will carry a steady load, and hence an expenditure with a view to obtaining economy is proper. The peaks of the Boston loads will be carried by the older stations, which contain the less efficient machinery. It would not pay the Boston Edison company to sell this old equipment, because it would bring in very little. In regard to cross-connections, he did not agree with Mr. Stott and Mr. Torchio. Cross-connections had been tried at the Atlantic avenue station, where every conceivable connection had been made. The result was that, within a short time, every one forgot the purpose of the different connections, and when trouble came there was no time to trace out the precautionary piping and wiring. In the Boston plant they had gone to the other extreme, and adopted no cross-connections.

As the hour was late, Mr. Moultrop asked to be allowed to continue the discussion in writing. The meeting then adjourned.

The Sixth Annual Convention of the Independent Telephone Association of Wisconsin.

Milwaukee, January 25 and 26, 1905.

THE sixth annual meeting of the Independent Telephone Association of Wisconsin was called to order in the convention hall of the Pfister Hotel at two o'clock, January 25; the president, Richard Valentine, of Janesville, delivered his annual address, showing the continued rapid progress being made by the independent companies throughout the state, that most of the companies had greatly increased their list of subscribers, and that exchanges were being installed in the cities of Green Bay and Depere. He stated that the reason for calling the convention a month earlier than usual was for the purpose of discussing matters of telephone legislation, which were to be brought up at the present session of the legislature. The bill prohibiting discrimination in telephone rates, which the association was advocating and which had passed the House by a vote of three to one at the last session but was defeated in the Senate by one vote, would again be urged for passage at this session, and he asked the active cooperation of all the members in securing its passage.

J. C. Harper, of Madison, discussed in full the bill to prohibit discrimination in telephone rates, showing the benefit it would mean to legitimate telephone interests and what hardship the present discriminations are to many of the cities. The bill was very nearly passed two years ago and with a little more cooperation by the companies throughout the state its passage would be assured at this session.

The bill was further discussed by Richard Valentine, of Janesville, and J. M. Baer, of Appleton.

J. J. Nate, of the Stromberg-Carlson Telephone Manufacturing Company, Rochester, spoke of the conditions in Minnesota, where the independents had built up the local territory but neglected to build toll lines. The Tri-State company of Minnesota was building up a fine system of toll lines and exchanges in Minnesota.

On motion that the chair appoint a committee on telephone legislation the following were appointed:

J. C. Kuoni, of Sauk City; J. C. Harper, of Madison; J. M. Baer, of Appleton; Philip Sheridan, of Green Bay; and E. A. Miller, of Hixton. On further motion the president was made chairman of this committee.

H. H. Davenport, of Green Bay, spoke of the work being done by the Valley Telephone and Telegraph Company, which was installing an exchange in Green Bay for 3,000 subscribers and one in Depere for 1,000, and also expected to develop that section of the state.

J. M. Baer, of Appleton, spoke of the good construction being put in by the company, which was sparing no expense to get the best, and which was putting in five miles of underground work, and the entire system was to be of copper wire.

A committee of three on resolutions was appointed as follows: G. W. Wilder, Chicago; Alfred Slater, Beloit; D. B. Bestor, Mazomanie.

Adjournment was then taken until ten o'clock the next morning.

The meeting reconvened on Thursday morning, January 26, and James B. Hoge, of Cleveland, president of the National Independent Telephone Association and of the United States Toll Line Company, made an address on the growth of the independent telephone business, stating that although the independents had started only ten years ago that they today had 2,500,000 subscribers. The rapid growth of the independents was still continuing and independent securities now had a much better standing than formerly. In most sections of the country independent trunk toll lines were being constructed. He urged that the state association should cooperate with the national, which had recently been consolidated with the interstate. The independent companies should advertise their long-distance business more and ought to adopt a uniform and standard toll sign. On motion of J. C. Harper a resolution was passed that the toll station sign adopted by the national association should be adopted by the independent companies of Wisconsin.

H. A. Nuttall, of Chicago, gave an address on "Ways and Wiles of the Bell Company."

G. W. Wilder, of the Armour Institute of Technology, Chicago, made an address on "Simultaneous Telegraphy and Telephony." He explained the system being successfully used in European cities and predicted that the telegraph service would become an important part of the telephone companies business in the future. The telegraph service could be rendered at a very small additional expense. The apparatus required is very simple and by means of condensers and retardation coils the two different currents are prevented from interfering with each other. A metallic circuit line is capable, by means of duplexers, of transmitting eight telegrams simultaneously.

E. C. Lewis stated that some of the railroad companies were using this combination system on their branch lines and were meeting with much success.

Mr. Hoge stated that the United States Toll Line Company was using these telegraph instruments in combination with their telephone lines quite extensively and was receiving an additional revenue of some $20,000 a year therefrom.

Don Farnsworth, of New York city, spoke on "Telephone Securities," stating that trust companies and the investing public were giving much more attention to telephone stocks and bonds than formerly. He was endeavoring to secure independent telephone statistics to show the vast development of the independent business and this would tend to give independent telephone holdings a firmer and better standing in the financial centres.

The following were appointed a committee to recommend officers for the ensuing year:

Charles Schernecker, of Sun Prairie; William Van Middlesworth, of Racine, and J. C. Harper, of Madison.

J. B. Hoge, president of the National Independent Telephone Association, advised that the state association affiliate with the national association, and a committee of three was appointed to confer with Mr. Hoge, consisting of H. C. Winter, of Madison; John C. Murdoch, of Broad Head; and W. F. Goodrich, of La Crosse.

Adjournment was taken until 2.30 P. M. Upon the meeting reconvening the report of the committee to confer with Mr. Hoge was made, advising that the Wisconsin association join the national association and recommending

that Mr. Valentine be elected member of the advisory board of the national association, and that three alternates be elected to attend the convention of the national association, which is to be held in Chicago next June; on motion the following were elected delegates: J. M. Baer, Appleton; W. F. Goodrich, La Crosse; J. C. Harper, Madison; and as alternates Dr. G. W. Wilder, Chicago; Philip Sheridan, Green Bay; and Charles Schernecker, Sun Prairie.

The secretary's report showed that 122 new independent companies were organized in the state the last three years, with $2,000,000 capital; that the increase in the number of companies and the steady growth of those now operating continue without lessening. A copper trunk toll line was now completed between La Crosse and Minneapolis, which gave good long-distance service between the Twin Cities, the important parts in Minnesota, Superior and Ashland in Wisconsin, and the Dakotas on the West. It was expected that this line would be extended into central and southern Wisconsin in the near future. There are to-day 275 independent telephone companies in Wisconsin, with an investment of $4,000,000, with 1,200 toll stations, 350 exchanges and 37,000 subscribers, of which number about 10,000 are farmer subscribers.

The committee to recommend officers, recommended the following officers for the ensuing year, which were elected:

Richard Valentine, Janesville, president; J. C. Kuoni, Sauk City, vice-president; H. C. Winter, Madison, secretary-treasurer.

Members of the executive committee: William Van Middlesworth, Racine; Philip Sheridan, Green Bay; J. C. Harper, Madison; W. F. Goodrich, La Crosse; H. V. Bartlett, Chippewa Falls; John M. Baer, Appleton; E. A. Miller, Hixton; and J. C. Crowley, Superior.

On motion it was decided to hold the next annual meeting at Milwaukee on December 20 and 21, 1905.

EXHIBITORS AT THE CONVENTION.

A number of manufacturers and supply men was represented at the convention, many exhibiting a large variety of telephone apparatus and auxiliaries. Among those present were the following:

American Electric Fuse Company—F. B. Patton.

American Electric Telephone Company—M. W. Zabal, H. A. Nuttall, S. J. Baer.

J. Andrae & Sons Company—H. P. Andrae, J. C. Schmidtbauer.

Automatic Electric Company—C. L. Fisher.

Frank B. Cook Company—F. W. Pardee, H. R. Cook, G. C. Fricke.

Dean Electric Company—R. H. Manson.

Electric Appliance Company—S. A. Densmore.

Electric Supply Company—L. W. Burch.

Eureka Electric Company—R. S. Mitten, C. W. Robbins.

Holtzer-Cabot Electric Company—E. R. Harding.

Independent Telephone Manufacturing Company—A. F. Adams.

International Telephone Supply Company—H. H. Deavenport.

Kellogg Switchboard and Supply Company—F. E. Rotchka.

Kusel & Kusel—H. J. Kusel, I. J. Kusel.

A. Meinema & Company—Albert Meinema.

Milwaukee Telephone Manufacturing Company—F. J. Whitmore.

Monarch Electric Wire Company—C. A. Kuhlman.

Monarch Telephone Manufacturing Company—E. E. Yaxley, W. H. Trimm.

North Electric Company—Charles H. North.

J. A. Roebling's Sons Company—W. H. Slingluff, Bond Wisler.

Signalphone Company—A. D. Weller.

Standard Telephone and Electric Company—M. L. Eldred, H. C. Biester.

Standard Underground Cable Company—E. J. Pietzcker, J. E. O'Neil.

Sterling Electric Company—W. E. Doolittle, C. R. Brown.

Stromberg-Carlson Telephone Manufacturing Company—J. J. Nate, E. C. Lewis.

Vought-Berger Company—J. G. Ball.

Williams-Abbott Company—L. Sand.

Extraction of Nitrogen from the Air.

In the London *Electrician* for January 6 appears a contribution from Siemens & Halske, of Berlin, referring to the calcium cyanamide process for fixation of nitrogen. It is said that the process is no longer merely a laboratory method, but is already at work in Berlin on a fairly large scale. In addition, the Societa Italiana per la Fabbricatione di Prodotti Azotati is building works at Piano d'Orta, in Italy, which will be able to produce 4,000 tons a year.

Calcium cyanamide can be used as a fertilizer instead of nitrate or ammonium sulphate. This fact has been established by experiments extending over three years, conducted by the royal agricultural testing station at Darmstadt and Posen. Experiments in this line have also been carried out at other places by well-known experts.

It is said in this communication that a new process of fixing atmospheric nitrogen has been devised, which is better than the cyanamide process, in that it eliminates one of the steps of the latter. For this method the nitrogen is fixed by heating lime and carbon and a stream of air in the resistance furnace, under determined conditions. This direct process of fixation dispenses with the previous formation of calcium carbide.

Eliminating Isolation and Distance from Farm Life.

At the recent annual meeting of the Kansas State Board of Agriculture, held at Topeka, Kan., Mr. Fred DeLand, treasurer of the Federal Telephone Company, Pittsburg, Pa., delivered an address on the topic of "Eliminating Isolation and Distance from Farm Life." Mr. De Land rehearsed the developments which had been made in improving the condition of rural communities. He called attention to the remarkable advance made since the invention of a practical reaper, and suggested that the only other invention which had brought to rural communities the same advantages was the electric speaking telephone. He sketched the development of the telephone from the crude apparatus of Reis to the present-day perfected apparatus. He described the first telephone line, and considered that this was not only the first line, but the first farmers' line and the first fence line ever built. It was erected thirty years ago, and was the forerunner of the 400,000 farm telephones now in use. In many ways the telephone was a great boon to the farmer. It helped him to market his produce and brought him in touch with many conditions that heretofore were impossible. It increases the earning value of many farms through helping to lessen the cost of operating and maintaining the farm property. He emphasized the necessity of a good understanding of the elements of telephone construction, and cautioned the farmer against using anything but first-class material; the best of construction being the cheapest in the end.

A CONTEMPLATED MAGNETIC SURVEY OF THE NORTH PACIFIC OCEAN BY THE CARNEGIE INSTITUTION.

BY DR. L. A. BAUER.[1]

A project for a magnetic survey of the North Pacific ocean by the department of international research in terrestrial magnetism has been favorably acted upon by the executive committee of the Carnegie Institution of Washington and authorization has been given to begin the work this year. An initial allotment of $20,000 has been made to cover the expenses for the current year.

As is well known, the state of our knowledge of the distribution of the magnetic forces over the greater portion of the earth—the oceanic areas—owing to the paucity of precise data, is exceedingly unsatisfactory. This fact is especially true for that great body of water, the Pacific ocean, rapidly developing in great commercial importance.

Captain Creak, for many years superintendent of the compass department of the British admiralty, now retired, says: "the North Pacific ocean is, with the exception of the voyage of the Challenger, nearly a blank as regards magnetic observations, and I, therefore, think the magnetic survey proposed will be of great value."

Hence, except for data from occasional expeditions and such as were acquired in wooden vessels a long time ago, the present magnetic charts used by the navigator over this region depend largely upon the observations on islands and along the coasts. Such land observations, however, are rarely representative of the true values because of prevalent local disturbances. It is, therefore, impossible to make any statement as to the correctness of the present charts. The demands of science, as well as those of commerce and navigation, require a systematic survey of this region under the most favorable conditions possible, and that the work be done under the auspices of some recognized research institution in order to ensure that the scientific aspects of the work receive their adequate recognition.

The eminent physicist and magnetician, Professor Arthur Schuster, states as his opinion: "I believe that no material progress of terrestrial magnetism is possible until the magnetic constants of the great ocean basins, especially the Pacific, have been determined more accurately than they are at present. There is reason to believe that these constants may be affected by considerable systematic errors. It is possible that these errors have crept in by paying too much attention to measurements made on islands and along the seacoast. What is wanted, is more numerous and more accurate observations on the sea itself." Furthermore, the superintendent of the United States Coast and Geodetic Survey, Mr. C. H. Tittmann, says: "there is no doubt in my mind that a survey for that purpose would result in obtaining data of great and permanent value and that it should be undertaken."

Additional quotations could be given; the above, however, are representative and show sufficiently the great importance of the proposed work and the fruitful results that may confidently be expected. It is the hope that upon completion of the magnetic survey of the North Pacific, the means will be forthcoming for extending the survey so as to include other oceanic areas. An effort will furthermore be made to secure the interest and cooperation of all civilized countries, so that we may look forward to the completion of a general magnetic survey of the accessible portions of the globe within about fifteen years. Thanks to the awakening and renewed interest in magnetic work shown on all sides, I fully believe that this hope will be realized.

The matter of prime consideration in magnetic work at sea is the elimination of the effects resulting from the ship's own magnetism as due to her construction and equipment. Such effects are especially troublesome to eliminate when it is proposed to obtain not only the magnetic declinations at sea, but also the other magnetic elements (the dip and the intensity of the magnetic force). The plan, therefore, to be attempted this year, as worked out by Mr. G. W. Littlehales, hydrographic engineer of the United States hydrographic office and consulting hydrographer of the department terrestrial magnetism of the Carnegie Institution, is in brief as follows: "to charter a wood-built, non-magnetic, sailing vessel of about six hundred tons displacement, which starting out in summer from San Francisco shall pursue a clockwise spiral course embracing the entire North Pacific ocean. The object of planning such a course is to gain continuous advantage throughout the survey of the dynamical agencies of the atmosphere and the ocean, in passing in succession into each of the five-degree quadrangles into which the chart[1] is divided and in which observed values of the three magnetic elements need to be obtained.

"The seasonal shifting of the permanent centres of barometric pressure will cause a variation from month to month of the conditions of wind and current that are represented on this particular chart, but if the departure from San Francisco be taken in the summer, the chain of meteorological events will contribute toward the maximum progress over the course, passing thence along the west coast of America to the vicinity of the Calapages Islands, thence across the Pacific in latitude between two and three degrees north, thence along the eastern side of the Philippine archipelago and the empire of Japan, thence eastward in about latitude fifty-two degrees north, thence to the latitude of San Francisco, and thence continuing through the series of areas, bounded by parallels of latitude and meridians of longitude each five degrees apart, lying next on the mid-ocean side of the circuit last made, and proceeding gradually and by successive circuits into the central region of the North Pacific."

The total length of the course marked out is about 70,000 knots; however, each of the first circuits practically closes at San Francisco, so that if it is found that the method pursued is not the best, the work can readily be terminated or modified. From enquiries made, it would appear that the entire work of observation and reduction can be accomplished in three years. The cost per month of the field work, inclusive of all expenses and services, will approximate fifteen hundred dollars ($1,500). Counting eight months of continuous service per annum, the total annual outlay is estimated at about twelve thousand dollars ($12,000).

This project as result of careful consideration and solicitation of expert opinion is believed to be thoroughly feasible. It permits of useful comprehensive results being immediately obtained, and is one which can be interrupted without any important waste of antecedent expense, whenever circumstances may render a discontinuance or a modification of the original plan advisable.

The region it is proposed at present to survey fortunately contains magnetic observatories in requisite number and proper distribution for furnishing the necessary corrections to be applied to the observed magnetic elements in order to reduce them to a common epoch. Thus continuous records of the magnetic variations required for this purpose will be available

[1] Director, Department of Terrestrial Magnetism, Carnegie Institution, Washington, D. C.

[1] The course to be followed was shown in red ink on a U. S. hydrographic office pilot chart of the North Pacific.

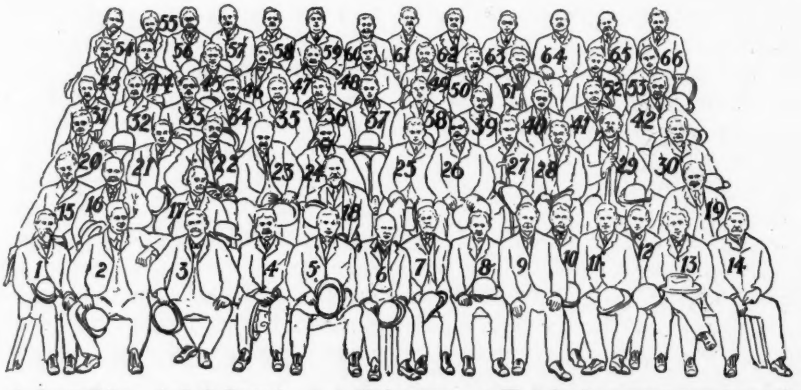
from the following stations: Sitka, Mexico, Honolulu, Manila, Shanghai, Tokio. In addition, it is hoped that there may be soon a magnetic observatory in California or vicinity for lending effective cooperation, and that the German government will continue its magnetic observatory at Apia throughout the period of the survey. Also excellent opportunities for controlling instrumental constants and obtaining required additional data will be afforded by stations on the coasts and on islands.

It should also be pointed out that the plan of the courses as mapped permits ready adjustment of the observed quantities for closed areas, in accordance with the potential hypothesis, and it may even permit to a certain degree the testing of the accuracy of this assumption, though as regards the latter more can be said at the end of a year's work.

While it is not anticipated that any marked irregularities in the distribution of the earth's magnetism will manifest themselves over the deep waters of the Pacific, it may confidently be expected that in the neighborhood of the islands and along the coasts distortions and irregularities will be revealed. With the aid of the results of the detailed magnetic survey of the United States and Alaska, opportunity will therefore be afforded of studying the effect of the configuration of land and water upon the distribution of the magnetic forces. The first circuit, passing as it does along the American and Asiatic coasts, will yield especially interesting results in this respect. Thus, for example, along the Aleutian Islands marked local disturbances will be disclosed. Reports are received frequently from mariners in this region regarding the unsatisfactory behavior of the compass; it is, therefore, greatly to be desired that a systematic magnetic survey of the waters in this region be made.

Additional information regarding the expedition will be given later.

SALESMEN AND HEADS OF DEPARTMENTS, ALLIS-CHALMERS COMPANY, MILWAUKEE, WIS.



1—James Tribe. 2—G. C. Forgeot. 3—A. Niedermeyer. 4—W. J. Sando, manager pumping engine department. 5—W H. Whiteside, general manager of sales. 6—W. J. Chalmers vice-president and treasurer. 7—B. H. Warren, president. 8—A. M. Mattice, chief engineer. 9—Arthur Warren, manager of publicity. 10—B. A. Behrend, chief engineer of electrical department. 11—C. C. Tyler, general superintendent. 12—W. M. S. Miller. 13—Ervin Dryer. 14—F. F. Coleman. 15—James Ashworth. 16—H. A. Allen. 17—W. W. Nichols, vice-president and secretary. 18—J. F. Harrison, manager flour mill machinery department. 19—Almon Emrie, superintendent Milwaukee works. 20—W. G. Starkweather. 21—J. R. Jeffrey. 22—C. J. Printz. 23—H. S. Mitchell. 24—I. L. Skeith. 25—G. C. Henry. 26—Robert Mulford. 27—J. C. Buckbee. 28—H. Woodland, assistant treasurer. 29 Clemens Herschel, manager hydraulic turbine department. 30—C. A. Burns. 31—H. L. Wells. 32—Franklin Wharton. 33—H. V. Croll. 34—G. L. Tifft. 35—J. D Millar. 36—W. C. Trout. 37—M. C. Millar. 38—W. A. Wood. 39—H. Schifflin. 40—J. A. Milne, comptroller. 41—H. S. Pell. 42—G. S. DeWein. 43—H. J. Holden. 44—M. J. Furlong. 45—George T. Thomas. 46—W. E. Dodds, superintendent of construction. 47—Richard Hoppin. 48—H. C. Helvey. 49—Albert Hoppin. 50—A. J. Gates, superintendent of Chicago works No. 1. 51—George L. Fisher. 52—W. N. Tanner. 53—Richard Barnard. 54—F. W. Greenleaf. 55—H. S. Mallalieu. 56—H. I. Keen. 57—J. O. Watkins. 58—R. J. Glendenning. 59—G. F. Collins. 60—R. D. Tomlinson. 61—C. A. Derby. 62—G. A. Berg. 63—J. C. M. Lucas. 64—W. O. Everett. 65—H. A. Hammil. 66—D. T. Jones.

The Personnel of the Allis-Chalmers Company.

The large group photograph herewith shows some of the members of the sales force of the Allis-Chalmers Company, as well as some of the officers and heads of departments who attended the meeting of the Allis-Chalmers salesmen recently held at the Reliance works of the company at Milwaukee, Wis.

The accompanying key will lead to the ready identification of each member of this group. A number of the men present have been the subject of personal reference in these columns from time to time. All are very prominently identified with contemporary progress in engineering and are well known throughout the engineering fraternity.

SERIES ALTERNATING ARC LIGHTING.[1]

BY E. P. WARNER.

During the past three or four years the very extensive introduction of series alternating arc lighting in the United States and Canada for the illumination of streets and public places has called for studious consideration of conditions and results. Valuable experience has been gained and it is gratifying to find that substantial advance has been made in both the reliability and cost of operation. Looking back at the old direct-current arc generators of a few years ago, with their very limited capacity and high cost for maintenance, and comparing them with the large direct-connected generators of the present day with their high efficiency, practically unlimited capacity, compactness and simplicity, the station engineer, and indeed all financially interested, can not fail to appreciate that in the series alternating system of arc lighting we have the practical solution of a number of problems, since, first, we may build our generators to any desired capacity; second, we may greatly reduce the floor-space required; and third, we may cut down cost for attendance and repairs.

REQUIREMENTS OF A MODERN SYSTEM.

The conditions which confront the engineers and others responsible for the welfare of large municipalities are such as to call for most earnest and careful study, and not the least exacting to meet are those pertaining to the lighting. What system shall we install and how shall we install it, are the questions for which answers must be found. The engineer or station superintendent is called on to consider the different system and plans of installation from the standpoints of reliability of operation, cost to install and cost to operate—in doing this he is sometimes hampered by local conditions, but, as a rule, is free to carry out his own ideas and make his own selection of a system.

In many of our large cities the lighting systems at present in use, a number of which has been installed within the last ten years, are so far from filling the demands of economy and certainty of operation that it will not be long before the increased service and reduced cost demanded will bring about their replacement by systems more fully filling all requirements.

In the series alternating arc lighting system of to-day we have a most practical, I may say beautiful, means by which the necessary electrical energy can be supplied to the different sections of a large city. Instead of a large number of small lighting stations scattered about the city, with their attendant nuisance of smoke, noise and dirt, their high cost to maintain and operate and many other objectionable features, we can have large stations located at a considerable distance from the city, where land would be comparatively cheap; also condensing water and fuel. From this station supply mains at high pressure can be run to any desired number of distributing stations equipped with transformers and regulators. Such a station would be practically noiseless, smokeless and, in fact, free from nearly all the objections that can be made to the present direct-current lighting station. Again, the cost of installation can be brought below that of the small separate stations and the cost to operate very considerably reduced. There is suggested by this system a practical solution of the problem of the smoke nuisance; we may some day have large stations located some distance from the city equipped with smokeless furnaces from which the city will receive its supply of light, heat and power.

PRACTICAL ARC LIGHTING.

In the past we have heard much regarding the relative lighting efficiency of different classes of arc lamps; the change from an open arc system to the alternating enclosed arc system often brings up the question of comparative intensity of light. Lighting committees and station managers must be satisfied regarding that point before they can make an intelligent selection of a system. The old commercial standard open arc lamp of 450 watts or 2,000 nominal candle-power, as adopted by the National Electric Light Association, has been an accepted standard for many years. Lamps of lower wattage have been used extensively, but the 450-watt lamp has come to be pretty generally recognized as best adapted for street lighting.

A 450-watt alternating enclosed arc lamp is fully equal to the old open arc direct current for street illumination in respect to the amount of light given, and far superior to it in the matter of lighting effect as demonstrated by the increased field of vision. The bright ring of light on the street and the dark spot under the open arc lamp are familiar to us all, but with the enclosed arc both are absent and a good average illumination of this field is obtained, which for the purpose of vision is much to be preferred. At a distance of 150 feet the light from the alternating arc fully equals that of the open arc and beyond that distance the difference is distinctly in favor of the former. I am here proceeding on the assumption that lamps are hung at the same height. We find, however, that the alternating lamp may be hung three or four feet lower than the open arc with a still further improvement in the effective illumination.

In the substitution of series alternating arc lamps for the open arc in tower lighting the results have been exceedingly gratifying. Lamps were used of about 420 watts at the arc with eighteen-inch metal shades, white enameled on lower surface. It was found that the light at and near the base of the tower was very much greater, while the general average lighting at a distance from the tower was fully equal to that given by the open arc. No adverse criticism of the conditions after the change was offered by the people living in the neighborhood, and a number of favorable comments were volunteered touching upon the increased steadiness and more uniform distribution of the light.

Central Station Equipment—In the equipment of a station for the operation of series alternating arc lamps, the choice of suitable switching and controlling devices becomes an important matter; not that these details are extraordinary in number or complication, but for the reason, as often happens, that there are several good ways of doing the same thing.

A switchboard should have a system of stab-switches, one for each of the two terminals of a circuit, so arranged that it may be transferred from one system of supply to another, and so that any circuit can be readily disconnected from its source of supply. The first provision is made with a view to permanency of operation of a circuit. Failure of a transformer or regulator should not compel the shutdown of a circuit for more than a very short length of time, and a simple means should be provided for bringing into service a new source of supply. This is ordinarily an extra regulator and transformer properly installed and connected to the switchboard, held ready for use in emergency. In very large installations it is necessary to have a number of such extra transformers and regulators, with connection buses running the entire length of the board, thus permitting the connection to any arc circuit by means of stab-switches. Transfer buses for interchanging the circuits are not used in the present practice to any great extent, it being found unnecessary to make trans-

[1] Paper read at thirteenth annual convention of the Northwestern Electrical Association, Milwaukee, Wis., January 18, 19, 20, 1905.

fers very frequently or to any very great extent. A good reliable ammeter should be installed in each of the arc circuits. This need not be an expensive instrument, but should be one reasonably accurate and allowed to always remain in circuit while same is in use. Where very high potentials are used, it is customary to use a current transformer to actuate the ammeter in order to insulate it from the circuit and thus render it safer to handle, and to reduce the liability of crossing to other instruments on the board. Where aerial lines are used, a good system of lightning arresters should be installed at a point on the circuits immediately after entering the station. It has been found desirable to disassociate the lightning-arrester installation entirely from the switchboard proper, making it a special feature of the installation.

Transformers and regulators can be installed in a separate room or building, if desired, and generally speaking this is a good plan for the reason that it more or less isolates different portions, thus reducing the risk of injury or loss from fire. The transformers used in many of the systems, where inductive regulators are employed, are of the ordinary constant potential type and may be either oil insulation or air cooled. Generally speaking, the efficiency of these transformers can be as high as that of ordinary constant potential transformers used with non-inductive load, and the combined efficiency of a transformer and inductive regulator supplying an arc circuit is fully equal to that of the best form of tub-transformer under any stage of load.

The usual practice to-day in the matter of regulators is to have all regulators of full-load capacity so that they not only serve as current regulators for small changes of load and voltage, but act also as safeguards in case of a complete short-circuit of an arc-circuit. Arguments have been advanced against this practice, claiming that it was unnecessary to provide such an extreme range of regulation and that safety from short-circuits could be provided by more inexpensive means. Whether this is true or not has not been demonstrated by any very extended practice. Of all automatically operating regulating devices known in the engineering world to-day, the inductive regulator stands forth as one of the most perfect pieces of electrical mechanism known in the art. It has been found so perfectly reliable in its operation that the average station manager will question the accuracy of his ammeter before he will that of the regulator. It is not an uncommon thing to hear the remark made when the current reads wrong, that "the ammeter must be off." A regulation of current to within one-tenth of an ampere, under quite extreme fluctuations of load and voltage, is easily accomplished and this so quickly that there is scarcely a noticeable fluctuation of the lighting power of an arc lamp in series, even when ten or fifteen per cent of the lights are extinguished at once. It is not a good plan to have regulators retarded by the action of the dash-pots or other retarding devices. Perfect reliability of action is best secured by leaving the coil free to move, and relying on the magnetic conditions to bring about stability in action and position.

In the mechanical construction of regulators it should be observed that they are strong, accessible, free from excessive friction in all moving parts, readily adjustable to load conditions and capable of operation at high efficiency and power-factor, and operate with little if any noise. Electrically they should be well insulated, sufficient ventilation should be provided in all portions of the windings to prevent accumulation of heat and excessive high temperature in any part.

Outside Construction Details—One of the most prolific sources of trouble on outside construction work lies in the lamp suspensions. Where lamps are suspended from span wires crossing the street, it is not uncommon to find a very poor insulator interposed between the lamp and the span wire. This often puts the full strain of the extreme voltage of the system between a lamp and the suspension wire to ground. Heavy leakage and general low line insulation are the results of such construction. In many cases the line loop extending from the pole to the lamp is brought to a small wooden cross-arm equipped with small porcelain knob insulators at each end, and from there extends downward to the terminals of the lamp, which is in turn insulated from the small wooden cross-arm by a single porcelain insulator, the cross-bar itself being practically uninsulated from the span wire when the lamp is hoisted into position. Under these conditions the line insulation is secured only by the small porcelain knobs at the end of the cross-bar and the surface of the cross-bar itself which in ordinarily stormy weather is entirely insufficient. Under the conditions described above, the lamp itself is also subjected to severe strain by reason of its insufficient insulation from ground. It is all very well to say that a series alternating arc lamp should be able to withstand a breakdown test to ground without damage to the insulation of 7,000 to 8,000 volts alternating current applied for one minute, but it has been demonstrated in practice that lamps which will stand this breakdown test when new and clean will fall very short of it after but a short period of actual service. The only practical way of securing good line insulation is to place a thoroughly good insulator above the lamp and above the cross-arm, if one is used, so that the line itself, as well as the lamp, will be insulated from the span wire. Under such conditions the necessity for any high-voltage test between the live parts of a lamp and the case is done away with and is, in fact, undesirable. No superintendent of a station, who has proper regard for the safety of the lives of his employés, will permit them to handle a live lamp while standing on the ground, and no matter what breakdown test a lamp may be said to stand, the employé should not place reliance on it, but should as thoroughly insulate himself from ground as though the lamp were alive in all parts.

Again, the argument may be raised that there is liability of the lamp coming in contact with some other wire and thus grounding the case. I think there are very few of you who would fail to realize that this is a very remote contingency indeed, and you will also realize that a breakdown test such as that outlined above would fall very short of preventing trouble in such a case, particularly after the lamps have been in service for some time.

Arc Lamps—In the early stages of development of the different series alternating systems, certain manufacturers attempted to make use of arc lamps in which the regulation was controlled entirely by shunt-winding, claiming that by using such a lamp they were enabled to secure very high efficiency with sufficiently good regulation. As time passed on lamps of this type were gradually eliminated from the field, and as an illustration of the survival of the fittest, we have to-day practically only the differential type of lamp, the shunt-controlled being a failure.

Now a few words as to the desirable features in the series alternating arc lamp.

1. It must be one in which the operating parts are few and of such design and construction that stock repair parts can be used in repair with facility and despatch.

2. The parts should be so assembled and attached as to facilitate removal and re-

placement, also to give ready access for examination and adjustment.

3. All material used should be of a character to best resist the action of the elements and ordinary wear and tear encountered in actual service. The quality of material used and its application should be a matter of careful scrutiny to the station manager, as therein lies part of the secret of reliable and continuous service. Do not let first cost be the prime factor in your choice of a lamp.

4. Regarding the performance of the lamp and the safeguard provided, I should say that it should be capable of regulating the voltage of the arc to the point adjusted within three volts in either direction, and when operated with a current of seven and one-half amperes, should give a life, with each trimming, of approximately ninety hours.

It is found in practice that variation in the sizes of the carbons, in the character of the core, in the density of the material used in the carbons, will considerably affect the length of life. This means that care should be taken in selecting carbons, though I think no greater amount is necessary than has been found to be the case with the old open arc systems. In all lamp mechanism there is a certain amount of lost energy; in a well-constructed lamp this loss should not greatly exceed twenty watts. The efficiency may vary somewhat with the different makes of carbons and the different stages of the burning, but the figures given above are a fair general average. The power-factor of an arc lamp varies with the quality of the carbons, with the position of the arc in the globe and also with the character of the cored material. It has been found possible in experimental practice to maintain an alternating arc, using two cored carbons of very rich material, at unity power-factor, but such results have not as yet been obtained commercially. With the ordinary carbons obtainable to-day, a general average power-factor of ninety at the arc can be obtained reliably. In estimating this power-factor we find the ratio of the true watts at the arc to the apparent watts. It has not been customary for purchasers to specify any stated performance in respect to the power-factor of the arc; they have contented themselves with the power-factor of the lamp as a whole. This, of course, is somewhat lower than the power-factor of the arc, varying in different makes of lamps. It is, however, a very important feature which must be considered by the purchaser and he should be careful to exact definite performance in this respect.

The durability of a lamp and the adaptability for long continuous service depend to some extent on the parts of the regulating mechanism remaining at a reasonably low temperature. In order to obtain such low temperature parts must be made of sufficient size and superficial area to readily dissipate the heat generated by losses in the mechanism and the heat which may be conducted from the arc. The rise in temperature by such mechanism after a run of twelve hours, should not exceed fifty degrees centigrade above the temperature of the surrounding air.

In the choice of enclosing globes it has been found that ordinary clear glass gives the greater general satisfaction, the distribution of diffusion of the light from the arc effected by the globe being practically as good as from any form of tinted or opalescent globe after one or two hours' operation. Practically the only reflector which can be used in combination with the alternating arc lamp is one placed above the arc and outside of the outer globe. I would say in this connection that certain users are making use of the reflector without employing an outer globe, making use of special tempered glass inner globes, which will stand the action of the elements very well. This is even accomplished in tower lighting, where the force of the wind is very great and rain and snow have full sweep. Reflectors which are very small can not be applied practically to the alternating arc, for the reason that the upper lobe of light is so disposed that it can not reach a reflecting surface which is very close to the central line of the lamp. This is true of the conditions in all positions of the arc in the enclosing globe. Effective reflectors can be and are applied which are so nearly flat discs that they do not offer much surface to the wind and hence do not cause the lamps to swing badly. The point has been raised that owing to the deposit of semi-opaque material upon the inner surface of the globe, the lighting efficiency is very materially reduced after a run of forty or fifty hours and that the deposit of this material is determined to some extent by the character of the gas cap or plate which closes the upper end of the globe. We have found this to be true to a very limited extent and that the lamp which had the metal gas cap conducted away the heat from the inner globe more readily and caused the lamp to run with a lower temperature in the inner globe, and thus to deposit less of the objectionable material upon the surface of the globe. Another result of this lower temperature was the fact that none of the material so deposited was burned into the surface of the glass, as is often the case in lamps where a high temperature is maintained. It follows, therefore, that the general lighting efficiency of a lamp with a metal gas cap is considerably higher than without.

It has come to my attention in a number of cases that the central station men engaged in making preliminary tests of arc lamps have endeavored to compare the different lamps offered on the basis of number of hours' service with one trimming. In this they have apparently lost sight of the fact that the number of hours' service with a trimming is controlled solely by the carbons and the amount of light given, the lamps having, in fact, nothing whatever to do with the result. In order to give a good steady light of sufficient power, it is necessary to admit a certain amount of air to the enclosure, restricting this amount only to the point where high lighting efficiency and reasonable length of life are obtained. We reach a point in this line of research where one line crosses the other; there we must stop, knowing that a displacement in either direction will give unsatisfactory results.

In this connection I should say that nearly all the reputable manufacturers of arc lamps of the present day are practically unanimous as to the most desirable conditions in respect to the above features, and it is only the unprincipled dealer who tries to influence the customers by claims for greater life than can be given with satisfactory lighting power.

In conclusion, I should say the results which have been achieved in series alternating arc lighting during the past three years are of a character to give confidence to the central station engineer that the system has come to stay, and is one which may be safely adopted with all the probable contingencies which may arise in the near future well in view.

The National Electric Light Association.

Considerable progress is being made by the committee in charge of arrangements for the next convention of the National Electric Light Association. This convention will be held in Denver and Colorado Springs, Col., during the week of June 6. The members of the committee in each of these cities are working under considerable strain to make the convention a remarkably successful one. The side trips that will be arranged for the entertainment of the delegates will cover those sections of the state that afford opportunity for inspecting electrical plants and construction in a mountainous country.

Reviews of Current Engineering and Scientific Literature.

The Nantes Transfer Bridge.

A transfer bridge has been put into service recently at Nantes, France. There are a number of these transfer bridges in Europe, but this bridge is built on somewhat different lines from those generally followed. The bridge is of cantilever construction, with an intermediate girder, the short end of the cantilever being held down by a counterweight. There are no oblique strains on the tower. The suspension is by hinges at the top of the tower, and therefore the load on the latter is vertical. The main span is 458 feet long, and the ferry is suspended by means of cables a short distance above the water. The height from the water to the bridge is 164 feet. The ferry itself is thirty-six feet in length and thirty-nine feet wide. It has a roadway and two side cabins. The pilot's cabin is built on the roof of one of the others, and from here the motion of the ferry is controlled. The transverse movement is given by a traction cable, which winds around an electrically driven drum. The driving machinery is located at one end of the bridge, all machines being in duplicate. The traffic across this transfer bridge amounts to 100,000 persons per month, and 800 carts and carriages.—*Abstracted from Engineering (London), January* 13.

The Metric System of Weights and Measures.

A general discussion of the advantages of the metric system, and of the advisability of adopting it in this country, is here given by Dr. A. E. Kennelly. The arguments used are already fairly familiar to those who have paid any attention to the proposed change. Some points of interest, however, are not so generally known. The metric system is by no means new in France. It was introduced in 1795, in the third year of the French republic, and its introduction was greatly aided by the upheaval of long-established customs in France at that time. During the first half of the nineteenth century France stood almost alone in the use of this scientific system. In the latter half of the nineteenth century other countries of Europe adopted the system. Spain did this officially in 1849, Italy about 1850, Portugal in 1852, Switzerland virtually in 1851 through the medium of a transition system, and finally in 1877, when the complete system was finally adopted. Germany and Austria-Hungary officially adopted the system in 1871; Russia semi-officially in 1900. Denmark alone in continental Europe declined to make the change, but it is said that the system is much used there, owing to the influence of neighboring countries. The pressure upon the continental European nations to adopt a uniform international system has been considerable, owing to their relatively close geographical association, but beyond this and the advantages claimed for the metric system, no pressure has been brought to bear. It is said that the change was brought about in a few weeks in Germany in the large cities, and in the country districts during the course of a few months. Within a year the metric system was practically universal. The manufacturers continued to use their old tools and standards, but they now graduated their products in the new units. As machines were renewed they were changed so as to produce even metric sizes. From this it is seen that the transition in this country should not require any machine, tool or piece of apparatus to be discarded. The difficulty of transition would not be in expensive new machinery, it would lie in translating the old familiar sizes made by existing machinery into the new units. The trouble would be intellectual rather than material. It is thought that it is only a question of time when the metric system will become universal.—*Abstracted from the Popular Science Monthly (Lancaster), February.*

Direct Wheatstone Working between England and Teheran.

Interest was aroused recently by the announcement that direct working had been established between Liverpool and Manchester, England, and Teherân, Persia. In this article Mr. T. W. Stratford-Andrews describes the workings of this line. Morse working had been employed throughout the company's system until it became inadequate to cope with the increase in traffic, and the Wheatstone system was experimentally introduced on the Odessa-Teheran section in the summer of 1897. It may be well to mention that this line, leaving London, passes through Lowestoft, England, and under the North sea to Emden, Germany; through Berlin, Warsaw, Odessa, Tiflis, Tauris to Teheran. Experiments with the Wheatstone system showed that signals could be transmitted satisfactorily in both directions along this section, but it was soon found that the Odessa office became blocked with messages intended for the west. The next step was to introduce the Wheatstone system between Odessa and Emden. As soon as this section of line was in satisfactory operation the two sections were amalgamated, making the operation between Teheran and Emden direct. This action then blocked the Emden office with westward messages, so that it became necessary to introduce the Wheatstone system on the Emden-London section. Over this section the Morse duplex had been worked, but full advantage of this system could not be taken because of the difference in time, as the bulk of the homeward traffic comes through during the daytime, and the out traffic comes by night. Before the Wheatstone system could be introduced on this section it became necessary to convince the English and German postal authorities that no disturbance would be caused by induction on the through wires in the Norderney and Borkum cables. Experiments were made with the Wheatstone system which satisfied the government officials at both ends, and the system was then introduced, and automatic transmission between Emden and London begun. Experiments were next made to test direct working between London and Teheran, a distance of about 3,800 miles. These were so satisfactory that this method of operation was adopted on January 1, 1903, and has been used since that time. During the last few weeks, as already stated, direct transmission from Teheran to Manchester and Liverpool has been going on. In addition to the general discussion of the system, Mr. Stratford-Andrews describes in detail the equipment of the London station.—*Abstracted from the Electrician (London), January* 13.

An Installation of Electric Power for a Quebec Mine.

The Eustis mine at Capelton, province of Quebec, has been a steady producer for over thirty years of sulphur, copper and precious metals. Recently alterations have been made in this mine, and electric power introduced. Heretofore steam has been used. Now a neighboring water power has been improved by means of a dam fifteen feet high. Two turbines have been installed, each rated at 450 horse-

power, which are directly coupled to 200-kilowatt Westinghouse, three-phase, 2,200-volt, twenty-five-cycle, revolving-field generators. Power is transmitted from the power-house to the mine, a distance of about two miles, by three bare copper wires. At the mines all the machinery is driven by means of induction motors. The air-compressor is operated by a 200-horse-power, 2,000-volt, constant-speed induction motor. The hoisting apparatus is placed at the end of an adit tunnel 1,000 feet long, through which power is conveyed by three weatherproof wires, which are protected by being placed in a heavy wooden box bolted to the wall of the tunnel. The hoist has two cast-iron drums, seventy-two inches in diameter and forty-eight inches long, mounted on separate shafts. Both drums are driven by one motor through a double set of gears. The drums are connected to the motor by friction clutches of the Lane type, provided with band brakes and indicators which show the position of the skips in the shafts at all times. The motor for the hoist is a 150-horse-power, three-phase, 2,000-volt, variable-speed induction motor, with a normal speed of 480 revolutions per minute. The controller has seven stops. It operates by introducing resistances in series with the rotating part of the motor. The mine incline varies from forty-five degrees to twenty degrees. At present it has a depth of 2,000 feet. The normal speed of the hoist is 500 feet per minute, but it has been found in actual practice that it takes only from five to six minutes for the skip to come from the bottom of the mine, discharge its load, and return again to the bottom. The crushing plant consists of a twenty-inch by six-inch Farrell crusher, with a set of gear rolls for reducing the hard ore to fine. These two machines are driven by a fifty-horse-power, 200-volt, slow-speed induction motor, supplied through two twenty-five-kilowatt transformers. When in operation these two machines absorb about forty horse-power, and crush eight tons of ore. In case of accident to the electrical machinery the hoisting apparatus may be operated by steam, simply by coupling an engine to each end of the countershaft hoist, an operation which requires very little time. —*Abstracted from the Canadian Electrical News (Toronto), January.*

Electric Tramways in Hongkong.

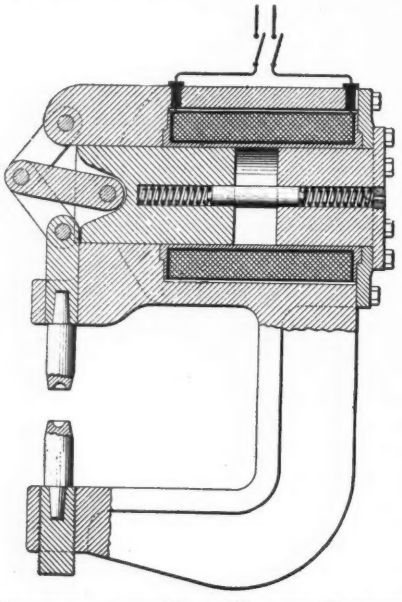
Since the island of Hongkong (China) became a British possession sixty years ago, its rise in importance as a commercial centre and naval stronghold in the far east has been rapid. The island is some eleven miles long, and from two to five miles broad, and consists mostly of lofty, uncultivated hills. In 1902 an ordinance was passed by the legislative council of Hongkong, authorizing an electric railway to be laid down by the Hongkong Tramway Electric Company. Work was commenced in May, 1903, and completed last July. The total length of track is fourteen and one-half miles, which is laid in nine and one-quarter miles of route. The gauge is three feet six inches. Girder rails are used, weighing eighty-six pounds per yard. The lines within the city of Victoria have, for the most part, centre-pole construction, but the eastern portion of the route, being outside of the city limits, has side-pole construction. With the exception of two short branch lines, the line runs parallel with the seafront. Owing to the varying nature of the ground, three forms of permanent way construction have been adopted. Where the ground was solid the rails were embedded on a concrete beam eighteen inches wide and six inches deep. Where the ground was not so good, a bed of concrete six inches deep, and seven feet three inches in width, extending under the whole track, was adopted; and for doubtful ground, which had been recently reclaimed from the sea, this concrete bed was made eight inches deep. The length of the brackets on the centre-pole construction does not exceed two feet. Where the side poles are used, the arms are about six feet long. The trolley wire is divided into half-mile sections by means of section insulators, and at each of these points the main feeder cables are tapped and current taken to supply the section. This is accomplished by running feeders through a feeder pillar containing the necessary switches and fuses. The feeders themselves are laid on the solid system underground. The generating station is placed on the side of the Bowrington canal, from which water for condensing purposes is obtained. The location is about midway of the system. Coal is delivered in barges. The equipment consists of two water-tube boilers of the Babcock & Wilcox make, and two Yates & Thom horizontal, cross-compound engines with a maximum output of 557 horse-power. These are directly connected to two Dick, Kerr & Company continuous-current railway generators. There are twenty-six single-deck motor cars, ten being of the combination type, and sixteen of the open, cross-bench type. Each car is mounted on a Brill truck, and equipped with two twenty-five-horse-power motors. Before the introduction of electric traction into Hongkong, the rickshaw, drawn by a Chinese coolie, was the principal means of locomotion. Of these nearly 2,000 were licensed for hire, in addition to a large number owned privately. While rather slow, the rickshaw is hard to beat for general convenience. The fight for supremacy between this and the new system will be watched with interest.—*Abstracted from the Electrical Review (London), January* 13.

Safety Devices for High-Tension Lines.

Ever since the high voltages have come into use in France efforts have been made to perfect certain safety devices which will prevent accidents from such lines, in case the wires should be broken. One of the most successful devices of this kind has been brought out by M. E. Giraud. This is here described, and an account given of recent government tests of it. The principle of the device is to actuate at the distributing station a cutout which will disconnect the line from the switchboard as soon as the rupture takes place, and before the wire, as it falls, comes within twelve feet of the ground. The device consists of a metal attachment fastened to the top of a porcelain insulator. In the upper part of this attachment is a tube, through which the wire runs loosely. At one end of this metal attachment there is a bracket, to which is hinged a long forked arm. This fork would hang down, but as long as the line remains unbroken it is held up by a hook fastened to the wire. Vertically below the main wire is a second wire, running also to the station, or it may be grounded. Should the line break, the tension on the wire is unbalanced. The latter then tends to slip through the sleeve, being drawn by the neighboring unbroken span. This movement of the wire draws the supporting hook toward the insulator, and thus throws down quickly the forked arm, bringing the latter in contact with the auxiliary wire. As soon as this contact has been established the disconnecting device at the station is opened. A device of the same character, though constructed somewhat differently, is attached to the auxiliary wire, and when the latter breaks a fork is thrown upward, making contact with the upper wire. For protecting trolley wires the trolley ear is mounted on a pin, and just above it are placed two contacts, against which the unbroken spans of wire are drawn should an adjacent span break. These devices have been subjected to somewhat severe tests, which, it is thought, demonstrate that they suppress all danger to persons who come in contact with a fallen wire. They disconnect the broken wire permanently, and this is done before the wire has fallen far enough to come in contact with passersby.—*Translated and abstracted from L'Industrie Electrique (Paris), January* 10.

Electrical Patents.

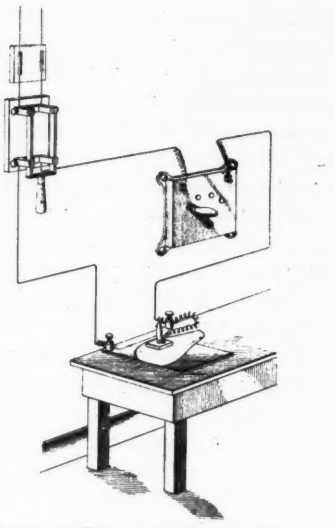
An electromagnetic metal-working machine, which has particular relation to machines in which the metal-working operation is effected by a single stroke, has been devised and patented (779,427, January 10) by Francis W. Jessop, of Cleveland, Ohio. The object of the invention is to enable the application to this purpose of an electromagnet, and consists in combining with the die, punch, shears, hammer, or other tool, an electromagnet and power-multiplying mechanism intermediate thereto, whereby a powerful blow may be imparted to the tool, and also in certain general and specific details of construction relating to the construction and arrangement of the magnet, multiplying mechanism, containing and support frame, and auxiliary mechanism. In carrying out the invention a frame is employed having an angular arm extending below its main body. The body of the frame is cored from end to end and in this cored-out portion is inserted a spool. A solenoid is carried by the spool. An annular cover-plate, secured to the frame, abuts against the spool, and a core extends within the spool and through the cover-plate being secured to the latter. A plunger also extends within the spool and is adapted to be actuated by the solenoid. Springs are seated in orifices in the core and plunger. A bridging-piece, between the core and plunger, extends into the orifices and engages the springs. A guide is located in the overhanging portion of the body, and a ram is movable in this guide. Toggle-links are connected respectively to the frame and ram. A link connects the plunger with the joint of the toggle. A tool is employed secured to the end of the ram and another tool is secured to the angular ram.



ELECTROMAGNETIC METAL-WORKING MACHINE.

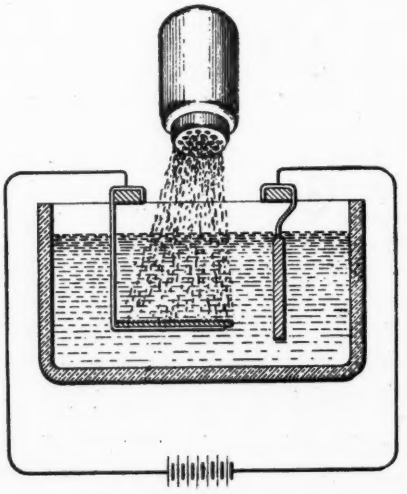
Edgar F. Price, of Niagara Falls, N. Y., has assigned to Union Carbide Company, of the same place, a patent (779,733, January 10) recently obtained by him for an improvement in electrodes. In a process hitherto employed, the chemical compounds are produced by electrolyzing solutions with an electrode of a metallic carbide, which will react chemically on the electrolyte, especially one of calcium carbide. It is, however, difficult to obtain pieces of calcium carbide of sufficient size, regular shape and uniform composition to serve as practical electrodes, and the reaction between the carbide and aqueous solutions is apt to disintegrate and destroy the electrode. The present invention is a composite electrode of the carbide and binder, the preferred binding agent being a coked hydrocarbon or carbonaceous substance, such as bituminous coal. To produce these electrodes, the carbide for example, calcium carbide, is crushed and mixed with the binding agent, for example, five to twenty-five per cent by weight of pulverized bituminous coal and a small amount of water-free tar or pitch. The mixture is then moulded into the desired form by a press or by forcing it through a die and cutting the product into lengths. The moulded pieces are then baked at a temperature sufficiently high to decompose the hydrocarbons and drive off the volatile matter, converting the bituminous coal and tar into coke. This coke not only binds the particles of carbide into a hard coherent body, but increases the electrical conductivity, and is especially useful when electrodes are employed in aqueous solutions, as it retards the action of the water upon the carbide, although its porosity permits the water to finally react on all of the carbide. The porosity may be decreased by saturating it with a liquid hydrocarbon or carbohydrate and again baking it, thereby depositing more carbide in the pores.

David C. Sprecher, of Kansas City, Kan. (779,810, January 10), has patented an improved electric branding apparatus, a one-half interest in which he has assigned to John E. Doran, of Kansas City, Mo. The object of the invention is to produce apparatus of this character whereby a clean and clear cut brand may be made upon hams, bacon, and other meat and substances, without seriously affecting the same and with either a low or high voltage. The apparatus is also portable and of convenient, simple, strong and durable construction. In the embodiment of the apparatus, a pair of conductors are employed and a switch for making and breaking a circuit through these conductors. A rheostat is in circuit with one of the conductors. An electric fuse is also in circuit with one of the conductors. An electrode is located at one end of one of the conductors, and a movable electrode is electrically connected to one end of the other conductor. This movable electrode is in the form of a branding-iron, having its contact-surface of materially less area than the first-named electrode.



ELECTRIC BRANDING APPARATUS.

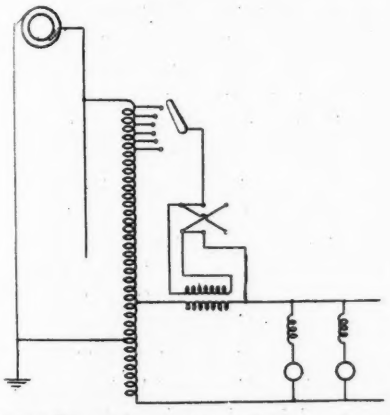
Edson G. Case, of Niagara Falls, has devised and patented (779,639, January 10) a method of fastening abrasive material to metal bodies. The object of the invention is to produce an abrasive surface which is practically inherent in the



METHOD OF FASTENING ABRASIVE MATERIALS TO METAL BODIES.

body to which it is applied, whereby the wearing qualities and permanency of the grinding or polishing surface are materially increased. To this end, the invention consists in the mechanical application of an abrasive substance—such as carborundum, emery or equivalent material to the surface or surfaces of a metal body and at the same time subjecting the body to an electroplating process, whereby as the abrasive is being applied to the body a metal coating is deposited over and around the surfaces of the abrasive deposit and metal body and permanently fixes the abrasive material thereto, it being understood that under this treatment the abrasive particles become embedded into and fastened by the plating.

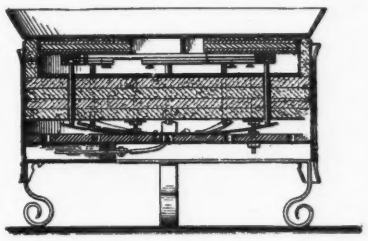
A single-phase alternating-current system of distribution is the subject-matter of a patent (780,048, January 17) recently granted to Paul M. Lincoln, of Pittsburg, Pa., and assigned by him to the Westinghouse Electric and Manufacturing Company. The object of the invention is to provide a system in which energy may be transmitted at high voltages and delivered through voltage-regulating apparatus to translating devices at lower voltages and in which the differences of potential between the grounded conductor from the source of energy and



Single-Phase Alternating-Current System of Distribution.

the respective terminals of the translating devices are reduced to safe and limited values. It has been proposed to operate by means of alternating-current energy motors of the commutator type of construction having series-connected armature and field-magnet windings, and being similar in many respects to ordinary direct-current motors. Various systems have been devised for transmitting energy at high voltages and supplying it at variable low voltages to motors at the points of consumption. In one system for this purpose the difference of potential between one terminal of the motors and the grounded conductor is the same as the potential difference between the motor-terminals, whereas in the system comprising the present invention, the differences of potential between the respective motor-terminals and the grounded conductor are only one-half that between the motor-terminals. With this arrangement the stresses on the insulation and the dangers incident to the operation or repair of the motors are materially reduced.

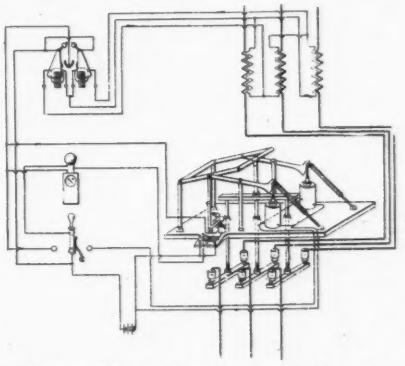
An electric stove in which heat is generated by passing an electric current through resistance wire has been patented



Electric Stove.

(780,228, January 17) by Earl H. Richardson, of Ontario, Cal., and he has assigned, by direct and mesne assignments, his entire interest in this invention to the Pacific Electric Heating Company, of the same place. One object of the invention is to provide for flexibility of that part of the stove which supports the dish or other object to be heated, and to employ for this purpose a plurality of contact or heating-blocks which are resiliently supported so that they will accommodate themselves to any unevenness in the bottom of the dish or object. Means are also provided for preventing heat from escaping in any direction except toward the top of the stove. The resiliency of the supporting heat-blocks is such that when the dish or other object to be heated is placed upon the supporting-blocks they are depressed by the weight of the dish, so that it rests upon the rim of the stove which further confines the heat and prevents escape of heat radially from under the bottom of the dish. The heat-block in which the resistance wire is arranged is of novel form, being so constructed as to take heat from both sides of the resistance wire, the top plate of the block receiving its heat directly from the wire, while the heat of the top plate of the heat-block is further augmented by receiving heat indirectly from the bottom plate and core, the ends of the heat-block receiving heat directly from the ends of the core and indirectly from the bottom side of the wire by conduction from the bottom plate, the bottom plate itself receiving heat directly from the bottom faces of the wire. The heat-blocks are so supported that when the weight of the dish or other object being heated is removed from the blocks they will assume a position which will cause them to separate slightly from the edges of the stove and form cracks or spaces which allow air to circulate around and under the heat-blocks to prevent excessive heating of the blocks when the dish is off. This is of special value in cases where the dish has been removed and through negligence the current has not been turned off from the heater. A central hole is formed in the heat-blocks which is adapted to receive a lug on the dish. The lug on the dish serves to hold the dish from displacement on the stove and the weight of the lug causes a close contact between the dish and heat-blocks to be maintained.

A circuit-making and breaking relay, having for its object to provide a simple and effective device of this character which shall be suitable for operation by either single or polyphase alternating currents in order to make and break either direct or alternating-current circuits, has been devised and patented (780,024, January 17) by Frank Conrad, of Edgewood Park, Pa., who has assigned the patent obtained thereon to the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. In the embodiment of the invention a



Circuit-Making and Breaking Relay.

polyphase, alternating-current circuit-making and breaking relay is provided, comprising two electromagnets, each of which is provided with an unsymmetrically located closed coil. Two metallic sectors have their upper ends pivotally supported and their lower ends project respectively into the fields of the magnets. The edges of these sectors are provided with contact-pieces, and a stationary contact-terminal is located in the paths of movement of these sectors and their contact-pieces. Adjustable counterweights serve respectively to normally hold the sectors and their contact-pieces in open-circuit positions.

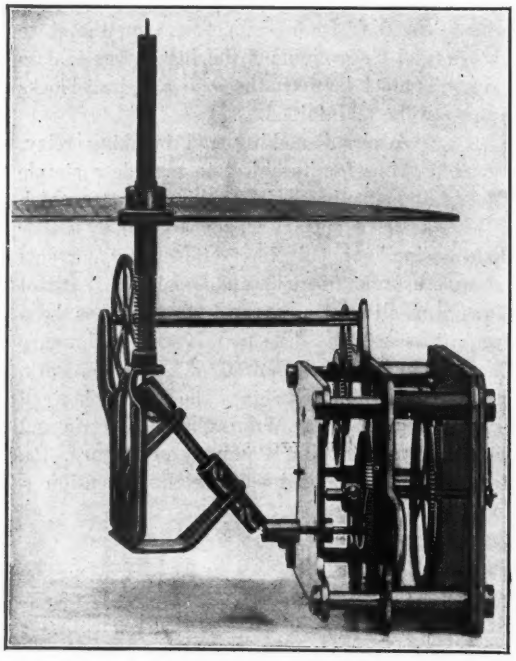
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

The Stanley Rotated Jewel-Bearing Wattmeter.

The Stanley Instrument Company, Great Barrington, Mass., has just placed upon the market a new recording wattmeter for alternating-current circuits, which contains many novel and remarkable features.

The principal characteristic of the meter, in which it is a radical departure, is that the jewel bearing upon which the disc-shaft pivot rests and turns is itself turned or rotated by the train gearing, so that a new jewel surface is constantly automatically placed under the disc-shaft pivot whenever the disc moves. The meter derives its name of rotated bearing wattmeter from this distinctive device, the details of which can be readily appreciated from the accompanying illustration.



STANLEY ROTATED JEWEL-BEARING WATTMETER.

The jewel-carrier shaft is connected with the train gearing by a bevel gear; whenever the train moves the jewel-bearing shaft must also move. The turning of the jewel bearing is a positive action operated by the system of gears constituting the train-registering mechanism. At every movement, no matter how slight, of the train gearing a new spot or point of highly polished jewel surface is automatically brought under the disc-shaft pivot. Consequently during each and every portion of a revolution of the pivot a new jewel bearing is automatically supplied.

The gear in the train-registering mechanism which rotates the jewel-bearing shaft is so arranged that the disc-shaft pivot can be in contact with the same spot or point of the jewel surface only one time during approximately 1,800,000 revolutions of the disc-shaft pivot; the equivalent of 1,000 kilowatt-hours.

For example, in a ten-ampere, 110-volt meter the disc will make 1,800,000 revolutions while the jewel bearing makes one revolution; and the train will register 1,000 kilowatt-hours.

For whatever period of time a jewel in a stationary-bearing meter will remain uninjured by the wear of contact friction, the same jewel in a rotated bearing must necessarily endure approximately 1,800,000 times longer without effect from friction contact.

In the rotating-bearing meter, no spot or point of the jewel surface can remain in contact with the pivot end long enough at any one time to be roughened in the slightest degree; because the pivot end is constantly moved from contact with any given spot on the jewel surface by every movement, no matter how slight, of the train gearing.

In the Stanley rotated-bearing wattmeter the jewel is so shaped that the disc-shaft is maintained in exact perpendicular alignment when the meter is connected up in service; there is not possible any effect upon the disc-shaft from side thrust.

The jewel is cup-shaped and the jewel-supporting shaft is at an angle of about forty-five degrees to the vertical disc-shaft. This places the jewel in an oblique position under the pivot and the pivot is thereby brought in contact with the junction between the sides and bottom of the cup, this junction being shaped in the proper curve.

The jewel carrier is a separate piece on the upper end of the rotatable bearing shaft and can be quickly and easily removed and replaced by any one, a skilled mechanic and special tools not being required.

The new Stanley rotated bearing wattmeter retains many of the characteristic features of the very popular Stanley meters of previous manufacture.

It is about the same size and of the same general appearance as the Stanley model "H" wattmeter, and retains the balanced thrust principle whereby is obviated the vibration of the disc by the alternating-current fluxes.

In addition to the elimination of hammering by the balanced thrust construction, the new Stanley rotated bearing wattmeter is further provided against the effects of vibration by having its disc-shaft pivot supported by a long spring contained within the disc-shaft, which, for the purpose of containing the spring, is a tube or hollow bore for a large proportion of its length. The upper end of the spring is in contact with the upper end of the hollow bore, the lower end being in contact with the head of the pivot. All the weight of the disc and its shaft rests upon the spring which is of sufficient length to make it impossible for any vibration to be transmitted from the disc to the pivot end. The spring removes from the pivot all vibration, whether of service, transformation, handling or premises.

The meter is shipped ready for connection into service, no clamping or adjustment of staff or pivot end being required for transportation or handling. The spring support of pivot and disc-shaft is so arranged that when the meter is in any position except when connected for service the pivot end is held firmly to the bearing and can not be jarred away or separated from it. When set up in position for service the disc floats smoothly and freely on its bearing. The pivot end is removable and can be taken off and put on again, or replaced by another, within a very few moments; no skilled mechanic or special tools being required.

In the new Stanley rotated bearing wattmeter the disc is 0.035 of an inch thick; five inches in diameter; the torque obtained is fifty millimetre-grammes; the ratio of torque to weight is ten to seven. It is, therefore, possible to obtain most easily extreme accuracy on the smallest loads as well as with the heaviest loads.

The maker cites the following example

of the permanence of adjustment of these meters: a rotated bearing wattmeter of ten-ampere, 110-volt capacity has been in circuit constantly, day and night, during more than eight months. It has been operated during this period without any brake magnet; the disc and its shaft rotating, consequently, at the high rate of speed of about 660 revolutions per minute. During this period and under these conditions the disc and its shaft pivot have revolved upon the rotated jewel bearing more than 150,000,000 times; registering the equivalent of 120,000 kilowatt-hours, representing a revenue earning, at the rate of ten cents per kilowatt-hour, of $12,000. At the end of that service, and during every week of the period, it was impossible to discover the slightest change in accuracy on any load from twenty-five watts up to fifty per cent overload.

It is suggested by the manufacturer that these meters be tested by the purchasers for frictional conditions in the following severe method: before beginning the special test ascertain the accuracy of the meter upon any desired load at stipulated rate of disc rotation; or determine the light load accuracy by comparing the full-load rate of disc rotation with the light-load rate which will denote the initial internal friction (if any) in the meters; then remove the brake magnet and let the disc spin around under full load for an hour, or a day, or a week; then replace the brake magnet and without change of pivot end or jewel test the meter again in the same manner to ascertain the difference (if any) between rate of disc rotation at light load or at full load or fifty per cent overload.

Another valuable feature of the new Stanley rotated bearing wattmeter is that it can be adjusted quickly and easily for any frequency from forty cycles to 133 cycles. This is accomplished by the magnetic shunt or bridge principle constituting an important part of the construction of all Stanley meters. The adjustment is of the simplest character, being merely the sliding of a contact on a small rheostat conveniently accessible; the change in resistance of the rheostat changes the reluctance of the magnetic circuit and thereby adapts the shunt system to alternating current of different periodicities.

The new Stanley wattmeter is made with two terminals, one at bottom, the other at top, for connection through the meter of the two wires of a two-wire circuit, or of the two outside wires of a three-wire circuit; the shunt connection being provided within the meter.

Where it may not be convenient or desired to take both wires of a circuit through the meter a shunt connection from one wire can be made with the upper terminal connection.

Another characteristic is the complete magnetic shield separating the shunt and current elements from the brake magnet system. This magnetic shield is the diaphragm or iron plate comprising the entire top or front of the case. Between this cast-iron front plate and the back plate of the case are contained the shunt and current coils which are thus completely enclosed in an iron box.

The brake magnet and brake adjusting screws, the disc-shaft and the train system are mounted on the side of the shield plate opposite from the coils. The excessively strong fields which necessarily result from short-circuits from lightning, or from abnormal voltage, or current overloads of any kind, are confined within the iron box and the brake magnet system is thus effectively shielded.

The cover of the meter is of all glass, one piece, or of metal with glass windows, as may be desired. The method of fastening the cover to case is patented and consists of a sealing band or ring which not only forms part of the means of connecting the case and cover, but also completely covers the joint between them.

The cover can be held to the case through the medium of the encircling band by the sealing wire which passes through a hole at one side of the band down along the side of the case, across behind the back of the meter, thence up the opposite side of the case to a hole in the other side of the band. Besides fastening the cover to the case this wire is a perfect and easily made sealing of the moving parts of the meter while permitting ready access to the terminal boxes to make connections to the circuit wires. The cover is additionally held to the case, through the medium of the sealing band, by the covers of the two terminal boxes. The cover is separately sealed, by wire and lead seal, to and around the case; each terminal box is also separately sealed, by wire and lead seal, through the heads of the screws fastening the terminal box covers to the case. By this method of enclosing and sealing, the meter with the glass cover can not be tampered with without immediate visual evidence of the interference. The meter can be connected with or disconnected from the circuit in the terminal boxes without removal or unsealing of the cover.

Standard Wiring for Electric Light and Power.

Mr. H. C. Cushing, Jr., author of the handbook, "Standard Wiring for Electric Light and Power," as adopted by the fire underwriters of the United States, has brought out the 1905 edition of this book, completely revised up to date. In revising this new edition Mr. Cushing was successful in securing the services of F. E. Cabot, secretary of the Boston Board of Fire Underwriters, and chairman of the electrical committee of the Underwriters' National Electric Association, to assist him with that part of the book which treats of the underwriters' rules and requirements. Mr. George T. Hanchett, consulting electrical engineer, assisted in checking up and revising the many valuable tables and formulæ to aid practical wiremen and contractors in determining the proper sizes of wire for all manner of construction work, for both direct and alternating currents. The new edition is handsomely bound in a flexible leather cover, and makes a complete and accurate pocket companion for the practical electrical engineer, central station man, wireman and contractor. It is also an accurate guide for the architect and builder, who are now called upon to embody not only in their own specifications but in their plans provision for electrical construction in all manner of buildings.

German Electrical Industries.

According to the report of United States Consul-General Guenther, Frankfort, Germany, the published statement of last year's business operations of the General Electric Company, of Berlin, shows a marked improvement. The gross profits were 10,439,000 marks ($2,484,482), against 6,984,000 marks ($1,662,192) in the preceding year. The number of employés was 27,487. The company declared a dividend of nine per cent on its share capital and carried large amounts over to reserve funds and to payments to directors and to benevolent endowment funds for employés. The company has a turbine manufacturing department which works on American designs, and has also established a department for making automobiles which has already turned out a large number of autos for passenger and freight traffic. The business lookout is excellent, as the company has orders for a long time ahead at very remunerative prices. The report of this company may be accepted as an indication of a general improvement of Germany's electrical industries.

The Switch Type of the Queen Decade Portable Testing Set.

Queen & Company, Incorporated, Philadelphia, Pa., has made a number of modifications to the switch type of the Queen decade set, which is shown in the accompanying illustration. Some of the valuable features in this instrument are as follows: contacts are made with very thin laminated phosphor-bronze brushes; the handles for moving the switches are double, allowing two decades to be moved without changing the position of the hand. This permits the operator to give his entire attention to the direction taken by the galvanometer needle when the switches are being changed. By the present arrangement of switches the resistance of the main stud does not enter into the circuit. The galvanometer is extremely sensitive, and is provided with a shunt having three shunting values. In one bridge-arm a standard condenser of one-third microfarad is mounted; also a ten milli-henry induction coil. In connection with this standard condenser a telephone receiver of extremely sensitive form is provided with each decade set.

SWITCH TYPE, QUEEN DECADE PORTABLE TESTING SET.

Provision is made in the set allowing the Wheatstone bridge, Murray loop, Varley loop, and all other usual tests to be easily and quickly executed. Switch and binding-posts are provided to permit the use of an outside galvanometer. Ten special dry cells are mounted in the case, and give an electromotive force of fifteen volts. They provide an exceedingly high-current capacity, each cell supplying about eight amperes on a short-circuit for a short time. A special interrupting alternating-current device is mounted in the lid. This makes it possible to test resistance, capacity or inductance in connection with the telephone receiver.

The maker states that these sets are in great favor with the telephone companies on account of the rapid adjustment of the resistance which is obtained. It is only necessary to watch the galvanometer and turn the switches until the galvanometer shows a deflection. This is much more rapid than the old method of changing plugs, and a balance can be obtained in about one-fifth of the time.

The instrument is described in detail in circular No. 403, issued by Queen & Company.

Switchboard Ammeters and Voltmeters.

The Troy Electrical Company, Troy, N. Y., is bringing out a new line of voltmeters and ammeters for switchboard work. In these instruments the working elements consist of a permanent magnet and two stationary coils, together with a pointer and its pivot, provided with a small steel vane. The moving elements in the instruments are made as light as possible. The steel vane is 0.01 inch in thickness, and 0.75 inch in diameter. The material in the vane is of specially selected stock in reference to its magnetic permeability, and its freedom from magnetic lag. No scale or oxide is allowed to remain on its surface. Vigilance in this respect gives an instrument perfectly reliable in its indications under all conditions, whether they be ascending or descending. The indications are caused to be dead-beat by a small aluminum damper.

SWITCHBOARD AMMETER.

SWITCHBOARD VOLTMETER.

The electrical losses are small, a 125-voltmeter having a resistance of over 3,000 ohms. This resistance is formed of an alloy having a very small heat coefficient, and renders the indications very accurate, irrespective of changes in temperature. The insulation of all instruments is subjected to a breakdown test before leaving the factory.

Special tungsten steel is used in the permanent magnet. In magnetizing, the steel blanks are subjected to a magnetic flux of maximum density, with the idea of affecting the molecules most difficult of movement; the theory being that actual movement of the molecules takes place. The direction of magnetic flux is then reversed, and its density is lessened, thus demagnetizing the magnet until but twenty per cent of the original charge remains. This twenty per cent is assumed to be due to the molecules most difficult to move, and therefore most permanent. Final ageing is done by subjecting the magnets to a long series of extreme temperature changes. The length of steel entering into the magnets is over fourteen inches, and the air-gap is very short, being bridged by the steel vane of the moving element.

All conditions necessary for permanent calibration are met. Hundreds of instruments have been made under this plan, and have shown no change whatever, despite constant and severe use. The instruments are extremely sensitive, and the scale is open throughout its length. By a peculiar arrangement, relatively to the poles of the permanent magnet and of the stationary coils, the scale is caused to be more open in the portions most used. This is an important point in a switchboard instrument which has to be read from a distance.

The instrument is on an iron base and has a carefully fitted iron cover. These form a good magnetic shield, and errors due to proximity of bus-bars or other conductors are thus eliminated. The diameter of the base is eight and one-half inches, and the length of scale, six inches.

American Electrical Fuse Company to Build New Factory.

The American Electrical Fuse Company, which now has factories at Chicago, Ill., Milwaukee, Wis., and Adrian, Mich., is to build a new factory at Muskegon, Mich. The other works will all be removed to the new plant. The company will employ 400 men.

A New Vertical Engine.

The American Blower Company, Detroit, Mich., is placing on the market a new vertical engine which possesses some unique features of great merit. The engine is shown in Fig. 1. It is fully

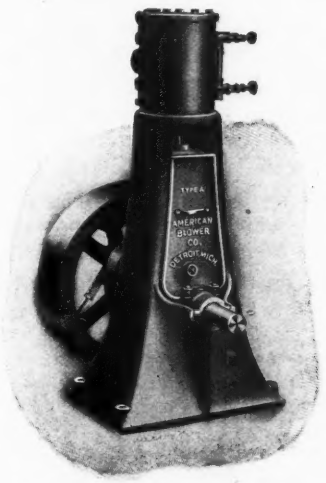


FIG. 1.—NEW VERTICAL ENGINE.

enclosed, preventing foreign matter getting into the working parts, the latter being easily accessible, however, upon the removal of the enclosing plates.

One feature of the engine is its oiling system, which is different from any of the usual methods, and has proved very successful. Every frictional surface runs on oil, there being no positive contact be-

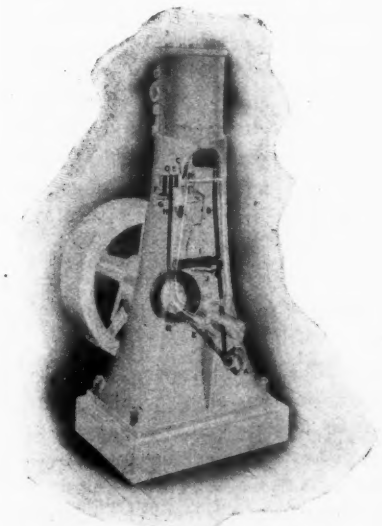


FIG. 2.—THE OILING SYSTEM.

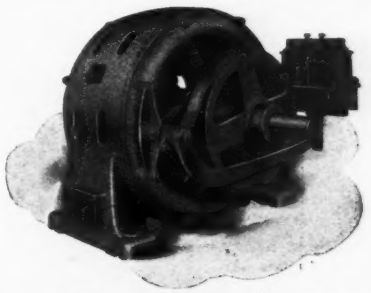
tween metals. This has the effect of almost eliminating wear. The oiling is done by the engine itself, and each bearing has a stream of oil.

The operation of the oiling system is shown in Fig. 2. An eccentric K on the shaft drives the plunger L, the oil pump A forcing the oil up through the tube B into the small strainer C. From C it drips into an oil box, through the bottom of which four tubes project. On one side of each of these tubes there is a slot, so that when the oil box contains only a small amount of oil, each tube can take only its proper proportion. In case the box is full, all the tubes get more oil in proportion to the increased height. One of the tubes F and one on the opposite side, not lettered, apply oil to the guides, the oil dripping into a small oil trough G, from which it runs into the bearing through an oil-hole. The cross-head pin is supplied by the tube marked E, the oil dripping into the cup H, filling the cavity between the bolt and inside of cross-head pin and the oil grooves. The oil dripping from the cross-head is caught in two pans attached to the inside of the cover. From these oil pans it runs down the inside of the cover, dripping into a cup in the top of the main bearing cap. Instead of using oil grooves at the top and bottom of the main bearing, the oil is supplied at the sides where bearing is cut away at the joints. The crank pin is oiled with the tube marked D, which discharges into a crank oil ring inside the eccentric, which, in turn, discharges into the crank-pin oil-tube, the oil flowing across the crank-pin bearing. The crank-pin oil-ring, in addition to its independent supply, catches the drip from one end of the main bearing. The eccentric is oiled by the drip which it catches from the other end of the main bearing. No difficulty has been experienced in catching the oil thrown off the eccentric strap, and splash from the cross-head has also been easily taken care of. A portion of the oil, as it drips back into the bottom of the frame, falls on an oil filter and is thoroughly cleaned and purified. The oil has an opportunity to cool and settle in the large base of the engine.

The manufacturer experimented on this engine in its own shops for some years. An engine was adjusted and filled with oil on March 10. Up to July 15 no adjustments of any character had been made, and no oil added, except to feed the sight-feed lubricators. The engine had been running from fourteen to sixteen hours a day, driving a blower, and after a lapse of over four months needed no adjustment or fresh lubricant. The maker states that the engine is particularly valuable for adaptation where continuous operation is required, or where peculiarly heavy duty is called for, as in operating dynamos, blowers, pumps, etc.

New Alternating-Current Solenoid Brake Applied to Induction Motors.

The accompanying illustration shows a new set for crane or intermittent service, developed by the General Electric Company, Schenectady, N. Y. The apparatus comprises a fifty-horse-power motor for crane service, and a new alternating-current solenoid brake. These sets are now in use in many large plants, among which may be mentioned the following: Great Northern Railroad shops, St. Paul, Minn.; Haggie Brothers' boiler shop, Joliet, Ill.; Edison Illuminating Company, Detroit, Mich.; Canadian Copper



INDUCTION MOTOR EQUIPPED WITH SOLENOID ALTERNATING-CURRENT BRAKE.

Company, Copper Cliff, Ontario; Canadian Pacific Railroad, Winnipeg shops.

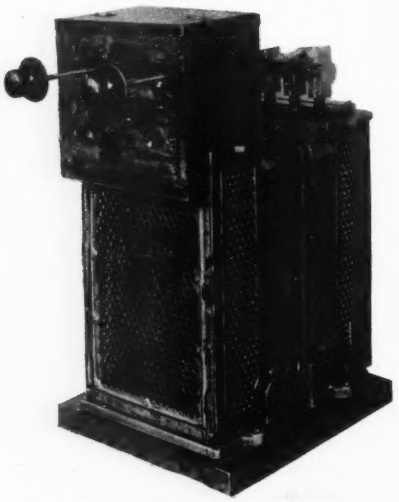
For some time the utility of the induction motor has been handicapped for crane service for the reason that no electric brake had been developed for alternating currents which would operate successfully under all working conditions. This new line of brakes has been built for various potentials and frequencies in four sizes, to be used with motors rated from one to seventy-five horse-power.

The magnetizing power is small and remains practically the same for all sizes. The momentary input at the full air-gap, which is governed by the type of brake, varies approximately in proportion to the weight of the movable core. The actual power required to operate the magnet is practically negligible. The solenoid works almost instantaneously, and the power consumed is required only for a moment. The power required to operate the brake thus amounts practically to the magnetization only, which is the power consumed by the solenoid when the motor is in operation. In tests made upon nine cranes operated by this General Electric induction motor and solenoid brake set, at the Great Northern Railroad shops, the switchboard ammeters at no time indicated any increase of current when the brake operated, neither was there any noticeable shock on the generators or engines.

The mechanical arrangement of the sets is very compact, the brake lever being placed close to the end of the motor underneath the shaft, with its fulcrum supported on one side and the solenoid on the other side of the motor.

Transformer Outfits for Thawing Pipes.

The manifest superiority of electricity as a thermal agent in thawing frozen pipes, and the field for this service that awaits development, has attracted a considerable amount of attention on the part of central station managers, many of whom have improvised outfits for this purpose. There has arisen a very general demand for thawing outfits that shall have a range in capacity to cover all ordinary requirements; shall be portable, easy to connect and moderate in price, and to meet this demand the Westinghouse Elec-



FRONT VIEW, TRANSFORMER FOR THAWING FROZEN WATER PIPES.

tric and Manufacturing Company has designed the two new types of transformers.

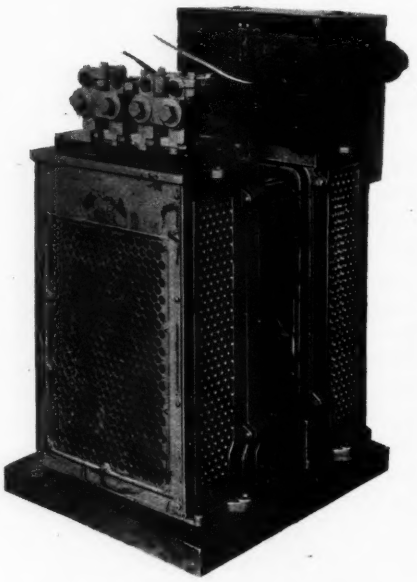
The larger of the two outfits (style No. 40,810, shown in the illustrations) weighs complete with transformer, switchboard and base 750 pounds. It occupies a floor space two feet four inches by one foot ten inches, and is one foot seven inches in height. A link in the top of the transformer case affords a means of lifting the outfit, and if desired truck wheels may be attached to the wooden base.

The transformer may be operated satisfactorily on circuits varying from 1,800 to 2,500 volts. The low tension is arranged to deliver approximately 500 amperes for several hours at an electromotive force from fifteen to fifty volts. By a simple change in connections, the windings may be arranged to deliver about 1,000 amperes at voltages from eight to sixteen, for thawing large mains whose resistance is generally low. It is suitable for thawing anything from a one-half-inch pipe to a one-foot main.

The transformer is generously designed, and will deliver large overloads for short periods of time. The windings are air-cooled. The insulation is not injured by rain, snow or ordinary abrasion. There are no moving parts to get out of order, and the entire outfit is contained in a single unit.

A light but substantial switchboard is mounted upon the high-tension end of the transformer. The switches are of the enclosed plug type, such as are used upon high-tension arc light circuits, and permit a variation of the low-tension voltage, and consequently the current supplied to the pipes. The switches are so arranged that it is impossible to make a wrong connection.

Transformer outfit (style No. 46,811) is smaller and is particularly adapted for thawing service piping about dwelling-houses. It is light, of such proportions as to make it easy to handle, and is mounted in a wooden box provided with a handle and shoulder strap. It has a capacity of 200 amperes at potentials up to twenty-five volts for one hour. It is arranged for operation off a nominal 200-volt circuit, but can be supplied for any other primary voltage to as low as 200



BACK VIEW, TRANSFORMER FOR THAWING FROZEN WATER PIPES.

volts. The voltage regulation and current control are obtained through plug switches in the high-tension circuit.

When desired, these outfits are furnished with a current-measuring device, so that the operator may know the amount of current that is being used.

Small Dynamos and Motors.

The R. M. Cornell Company, Syracuse, N. Y., is placing on the market a line of direct-current dynamos and motors, consisting of experimental machines from the smallest made, up to one kilowatt for commercial purposes. It is expected, that when completed, this line will show the largest variety of small machines on the market, especially in small sizes for experimental purposes.

The accompanying illustration shows the "Wonder" dynamo, which is the smallest generator of its kind on the market. It has an output of about twelve watts and is wound for a number of different voltages. In bringing out this machine it is the aim of the maker to put on the market a small generator following in every detail the construction of a large commercial machine. Among its special features are a laminated armature, adjustable brushes, large and strong com-

NEW TYPE OF SMALL DYNAMO.

mutator, heavy interchangeable bearings. In its construction it is the aim to make the machine complete and efficient; to be used where a small amount of current or power is required and especially desirable in connection with experimental work. As a motor it will operate running light on about two watts of current and with sufficient battery will do considerable work. It is also wound to run in series on a 110-volt lighting circuit. All parts are interchangeable and made of the best material. The company will offer for sale its different size machines as fast as it has them ready for the market.

A Device for Measuring the Wear of Trolley Wires.

A device for measuring the wear of trolley wires has been invented by M. A. Harrich, of Ratisbonn, Germany. It consists of a tube, which may be slipped over the wire, and which is pressed against the latter by a thumb-screw. The tube carries a disc and a system of levers, which, when the device is attached to a wire and then rotated, will trace the outline of the wire, multiplied 100 times, on a sheet of paper attached to the disc. A view of such a diagram is given, showing that the wire is worn away at the lower part, leaving practically a flat surface.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIFICATION OF SOUTH AMERICAN RAILWAY SYSTEM—The only horse-traction system now operating in Buenos Aires, South America, and owned by the Ciudad de Buenos Aires Traction Company, is to be changed to an electric line. Work is to be commenced at once, and it is expected that the change will be completed by June of the present year.

POWER PLANT FOR THE BLACK HILLS—It is announced that the Black Hills Electric Light Company, at Deadwood, S. D., and the Belt Light and Power Company's plant, at Lead, S. D., will be consolidated. J. J. Henry, a Denver business man and projector of electrical enterprises, is said to be interested in this proposition. The plan contemplates a new installation at Pluma, to generate 5,000 horse-power.

MUNICIPAL LIGHTING PLANT FOR BUFFALO, N. Y.—At the meeting of the board of aldermen of Buffalo, N. Y., January 16, Commissioner of Public Works Ward was instructed to prepare plans giving the estimated cost of a lighting plant for the city of Buffalo, and the cost of maintenance. The time limit which was given for the preparation of this report was thirty days. Mr. Lewis Stockton, president of the Referendum League of the city, stated that the question would be decided by a referendum vote. It is expected that the city would have to be bonded for $6,000,000 in order to carry the idea through.

THE POWER PLANT OF THE CHICAGO DRAINAGE CANAL—Much interest is being manifested in the progress of the work of the sanitary district of Chicago, Ill., which is undertaking a system of electrical supply, the source of power of which lies in the Chicago drainage system. At the present time the channel excavation work is being prosecuted with great vigor. The plans have been prepared for the power-house, and a contract has been entered into for the water-wheels. Specifications are ready for the electrical equipment, but as there are interference proceedings relative to the placing of the contract for the water-wheels, the electrical specifications will not be contracted for until the complication is settled.

NEW ELECTRIC ROAD IN MEXICO—A company known as the Ferrocarril, Jalisco & Michoacan, *via* Chapala, has been organized at Mexico City for the purpose of building an electric road from Guadalajara to lake Chapala. The capital is said to be $1,500,000. The railroad is to be of the latest and best construction. After building the line from Guadalajara to lake Chapala it will run along the shore of the lake, crossing to Zamora, Michoacan. The company will have various branches in the states of Jalisco and Michoacan. The concessions have been secured, and during the past two years about $40,000 has been expended upon the preliminary surveys and other expenses. Among the officers are Carlos L. del Hoys, Zamora, president, and William V. Backus, vice-president and treasurer.

UNITED STATES STEEL CORPORATION TO EMPLOY ELECTRICITY ON ITS ORE-MOVING LINES—It is expected that the United States Steel Corporation will change the motive power on its two principal ore roads from steam to electricity some time this year. The roads to be changed are the Duluth & Iron Range, and the Duluth, Mesaba & Northern. These two systems are the chief transportation elements in getting iron ore from the mines in the Mesaba range to the lake ports. It is understood that the company will get its power from the Great Northern Power Company, which is proceeding with the work of construction on its power installation on the St. Louis river, near Duluth. It is claimed that there is available not less than 200,000 horse-power at this point. The initial installation, however, will be for about 30,000 horse-power.

THE EXTENSIVE PLANS OF THE BROOKLYN RAPID TRANSIT COMPANY—The Brooklyn Rapid Transit Company will make large expenditures within the next two or three years, looking to the improvement and extension of its already large property. Some of the changes are already in progress. The most important of these is the lengthening of all the elevated railway station platforms on the Fifth avenue & Bay Ridge and West End lines. This will permit the running of six-car trains instead of five-car trains during the rush hours. It will enable these two lines to carry back and forth to Manhattan 5,000 more passengers per hour than formerly. Another important improvement is the erection of a $6,000,000 power plant, with a capacity of nearly 100,000 horse-power. This plant will probably be built in the Williamsburg section of the borough of Brooklyn. Two hundred new cars of modern design will replace the cars now running over the new Williamsburg bridge. A considerable expenditure of labor and money is now going on in converting some of the rolling stock which the company owns at present, rendering this absolutely fireproof.

NEW YORK CITY MUNICIPAL PLANT TO USE WASTE FUEL—It has been announced that an experimental plant will be installed by the municipality of New York to furnish current for lighting the new Williamsburg bridge, connecting the boroughs of Brooklyn and New York. The proposition is to run the electrical plant in combination with a refuse destructor. The street cleaning department has operated an incinerator in New York city for over a year with results that appear to be satisfactory. If the plant is built upon the lines already under consideration there will be an excess of current generated. Possibly, some of this may be used in adjacent public buildings. The cost of erecting the plant is placed at $75,000. The Street Cleaning Department has advertised for proposals for the contract to build the incinerator. The incinerator will be located in the block between Tompkins and East streets, Manhattan, under the bridge structure, facing Delancey street, where the terminal of the bridge is. The specifications of the contract for the construction of the incinerator call for a building with a frontage on Delancey street of seventy feet, and with a total depth of 150 feet. No bid in excess of $27,000 will be received. The time allowed for the completion of the work is ninety days. The successful contractor will have to deposit a security of $15,000 to ensure the proper completion of the building. The bids will be opened at noon on February 15.

EDUCATIONAL.

THOMAS S. CLARKSON MEMORIAL SCHOOL OF TECHNOLOGY—The Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., in its bulletin for October, 1904, publishes an interesting short article on "The Application of the Temperature-Entropy Diagram to the Analysis of Gas-Engine Tests," by Frederick O. Willhofft, professor of mechanical engineering.

THE ARMOUR INSTITUTE OF TECHNOLOGY has recently been the recipient of a complete line of telephone protection apparatus which was donated to the institution by the Frank B. Cook Company, of Chicago. The institute has been preparing a four years' course in telephone engineering, and the opening of the present winter term found a large class of young men anxious to take up this line of work. The telephone laboratory has been equipped with a complete line of telephone apparatus, the larger manufacturing companies having donated very liberally to this department. The protection apparatus mentioned above consists of a large distributing frame completely equipped with all styles of protective devices manufactured by the Cook Company. A large supply of latest type heat coils, fuses and lightning arresters was included in this apparatus. Special testing devices and other apparatus necessary for experimental purposes accompanied the outfit. The distributing rack has been wired to two experimental switchboards which were given to the institute last year by the Stromberg-Carlson Manufacturing Company.

ELECTRIC RAILWAYS.

VINTON, IOWA—A franchise has been voted to the Vinton & Belle Plaine Electric Interurban Railway Company.

CHAMBERSBURG, PA.—The Chambersburg, Greencastle & Waynesboro Electric Railway Company will extend its line from Pen Mar to Gettysburg. This will be one of the three trolley lines that it is promised to enter Gettysburg during the coming summer.

ITHACA, N. Y.—The contract for the immediate construction of the Cayuga Heights extension of the Ithaca street railway system has been let to the Syracuse Contracting Company. That firm has given a bond to complete the grading of the road on or before May 15.

BLOOMINGTON, ILL.—The stockholders of the Springfield & Northwestern Interurban Company have voted to issue $700,000 in bonds to cover the cost of construction and power-house for the line between Springfield and Bloomington, the power-house being in Lincoln.

EUREKA, CAL.—Another electric railroad for Eureka is assured, and the suburban lines to Arcata, ten miles to the north, and Ferndale, twenty miles to the south, will be constructed. J. E. Green and J. M. O'Brien, of San Francisco, have applied for a franchise, and will begin work shortly.

GOSHEN, N. Y.—On Thursday, February 23, at the court house in Goshen, Russell Wiggins, as referee, will sell to the highest bidder the Middletown-Goshen Traction Company's road. At the same time W. J. Groo, as referee, will sell to the highest bidder the Middletown-Bloomingburg electric road.

LAKE CHARLES, LA.—The Lake Charles Street Railway Company has been purchased by the stockholders of the Lake Charles Ice, Light and Waterworks Company for $20,000. The line is about a mile long and operated by mule power. The new purchasers intend to extend the line and equip it with electric power as soon as conditions permit.

NEW HAVEN, CT.—The New York, New Haven & Hartford Railroad has taken over another trolley line, the Berkshire street railway, which runs from Great Barrington, Mass., to Cheshire, about thirty miles. It paid about $800,000 for the road. The bonds are for three per cent for the first few years of their running, and for three and one-half per cent afterward.

NASHVILLE, TENN.—Local capitalists have purchased the rights, privileges and franchises of the Nashville & Columbia and Nashville & Galatin interurban road, and it will be pushed to completion. The road, which will be electric, will extend from Gallatin, Tenn., through Nashville to Mt. Pleasant, Tenn., a distance of about seventy-five miles.

VERSAILLES, KY.—The Woodford County fiscal court has granted to Clifford D. Bebee, of Syracuse, N. Y., a franchise and the right of way for an electric railway from Lexington *via* Versailles to Frankfort. The sum of $2,500 must be deposited in the county treasury in thirty days, to be forfeited to Woodford County if the road is not in operation by April 15, 1906.

CONCORD, N. H.—The men interested in the proposed Derry & Manchester Railroad Company, a bill for the incorporation of which has been presented in the legislature, are Walter M. Parker, W. J. Holt, Noah S. Clark, George H. Chandler, Harry E. Parker and Roswell Annis, all of Manchester; David F. Perkins, of Londonderry; Edwin N. Whitney and C. N. Greenough, of Derry.

DETROIT, MICH.—The Detroit United Railway is enlarging its power-house to accommodate an additional 2,000-horse-power unit with engines, boilers, generators and distributing apparatus. The company has contracted for fifty new double-truck cars, twenty-five of which will be built by the Brill company, and the remainder by the St. Louis Car Company. The total outlay involved is $400,000.

OMAHA, NEB.—A meeting of the directors of the Omaha, Decatur & Northern Interurban Railway Company was held recently at Tekamah, when J. B. Latta was chosen director, *vice* T. B. Gordon, resigned. A contract was entered into with C. B. Pierce and L. F. Wakefield, of Sioux City, for the construction of seventeen miles of road between Decatur and Tekamah. Prospects are reported as being very bright for the completion of this portion of the road by the first of October next.

ANDERSON, S. C.—The first annual meeting of the stockholders of the Anderson Traction Company was held January 10 and it was decided to mortgage the property of the system to the extent of $50,000 to secure funds to continue the work. The system is more than half completed and its affairs are in good shape. The work of construction has been considerably hampered by bad weather during the winter. The wires are now being strung, and it is announced that cars will be running at an early day.

WALLA WALLA, WASH.—E. S. Isaacs, of Walla Walla, has been granted a twenty-five-year franchise by the county commissioners for ten feet of the roadway on county roads near the city for the operation of an interurban motor line in connection with the street railway line which he purposes to operate in this city. It is likely that as soon as electric power can be obtained from the plant on the Walla Walla river Mr. Isaacs and his associates will begin construction of a street car line in Walla Walla.

BALTIMORE, MD.—The management of the United Railways Company contemplates the erection of another generating power-house on Eastern avenue, Baltimore, at the junction of the Back river and Steelton lines, and has sent out plans for a large structure to be built entirely of concrete. The drawings call for a building about fifty feet high, one story and two galleries. The structure will be about thirty by ninety feet, and will have a basement. It will be one of the first buildings in Baltimore to be constructed entirely of concrete.

MEMPHIS, TENN.—The Fort Smith, Ark., Light and Traction Company has filed an amendment to its charter increasing the number of directors from five to nine, and the capital stock from $1,000,000 to $1,600,000. The amendment also specifies that the holders of preferred stock shall be paid a fixed dividend of five per cent, the common shareholders to receive their dividend when the preferred stock has been given the amount due on it. Robert J. Grof, Isaac B. Mikewich and L. W. Jennings, of Chicago, have been named as new directors.

COLDWATER, OHIO—At a meeting held at Coldwater and attended by citizens from Celina, Ft. Recovery and St. Henry, Z. E. Hamburger, of Celina; B. B. Wilson, of Ft. Recovery; H. A. Beckman, of St. Henry; and H. C. Fox, of Coldwater, were selected as a committee to look up the most feasible route for a traction line connecting the towns named. Following is the route proposed by this committee: Celina to Coldwater, on line of right of way secured two years ago by Indiana promoters; from Coldwater to St. Henry, and from St. Henry to Ft. Recovery on one of two routes not yet determined. It is the object of this committee to secure the right of way and then dispose of it without profit to some responsible company that will build a road.

DELTA, COL.—The board of county commissioners has granted an electric road franchise to W. B. Stockham and Charles Pike. The road will consist of two separate lines, one of which will run from Delta to the Grand Mesa lakes, *via* Eckert, Cedar Edge and the four coal banks on Surface creek. The other branch goes from Delta to the Smith's Fork anthracite coal fields. The entire mileage will be about ninety miles. The farmers and fruit-growers have given the right of way along most of the route, in addition to which they are subscribing for five dollars of common stock for each acre of land which they own, and which adjoins the right of way. The new company under the terms of its franchise must construct not less than five miles of road per year. Work will probably commence within ninety days.

GLENDIVE, MONT.—At a special meeting of the commissioners of Dawson County a franchise was granted H. J. Haskell, E. S. Baer, B. S. Adams, J. J. O'Brien and J. R. Widwyer, petitioners for the Glendive & Yellowstone Valley Rapid Transit Company, to build an electric railroad and telephone line from Glendive to a point on the Missouri river opposite Buford, N. D., a distance of eighty miles. The company is to incorporate within sixty days and begin construction within six months after the granting of the petition. The road will traverse the entire length of the lower Yellowstone valley, in which the government will begin the construction of irrigation work in the spring, which will cost approxi-

mately $3,000,000 and reclaim 60,000 acres of land. The new road is important, as it will form a connecting link between the Northern Pacific and the Great Northern railroads.

NEW HAVEN, CT.—The directors of the Consolidated Railway Company have voted to double-track the Highland division from Turners to Danbury.

BENICIA, CAL.—F. A. Brand, president of the Benicia Iron Works, has petitioned the board of trustees for a franchise to build and operate an electric railway in the town.

RICHMOND, VA.—The Citizens' Rapid Transit Company, which purposes to build a viaduct from Church Hill to Shockoe Hill and run a trolley line over it, has put up $5,000 of its four per cent bonds as a guarantee that the work will be done.

OKLAHOMA CITY, O. T.—Oklahoma capitalists, who are interested in real estate on the south side of the Canadian river, in Capitol Hill, are contemplating putting in a line which will connect with the present street railway system.

MARION, IND.—A plan is on foot looking to the building of an electric railway between Hobbs and Greentown, passing through Windfall and connecting the lines of the Union Traction Company, and the Kokomo, Marion & Western traction line. Hobbs is located five miles east of Tipton.

DAYTON, OHIO—L. W. James, receiver of the Dayton & Kenton Traction Company, has been empowered to sell the assets of the concern, consisting of options, rights of way and office fixtures, to Hugo Cook and Michael Chambers, at their bid of $980. They were the only bidders.

WASHINGTON, D. C.—The United States Senate has passed senate bill 3343, authorizing the Anacostia, Surrattsville & Brandywine Electric Railway Company to extend its street railway into the District of Columbia. This authorization allows the railroad to carry passengers, parcels, milk, garden truck and other small freight.

SPRINGFIELD, OHIO—The American Railways Company, which controls the plants of the Springfield Railway Company and the Springfield Light and Power Company, will erect a new electric light plant in connection with the Springfield Railway Company, work to commence immediately. About two miles of electric lines will be built this spring and summer.

CHARLESTON, S. C.—The Charleston-Summerville Electric Railway Company has been organized in this city, and it is expected that work of construction will be started almost immediately. The legislature will be asked to allow the railway to cross Dorchester and Lawson's roads. The route extends over private property with the exceptions named. The company has been given a franchise to run through certain streets of Charleston.

POTTSTOWN, PA.—Under a perpetual lease the Pottstown Passenger Railway trolley line has passed into the control of the Pottstown & Reading Street Railway Company, the officers of which are: president, Samuel H. Ashbridge, former mayor of Philadelphia; general manager, John Blair McAfee, of Philadelphia; acting superintendent, J. P. Pope, also of Philadelphia. It is the intention of the lessees to extend the line, which is six miles in length, to Reading.

CLEVELAND, OHIO—At the annual meeting of the shareholders of the Lake Shore Electric Railway Company the following-named gentlemen were elected directors for the ensuing year: E. V. Hale, J. R. Nutt, H. A. Everett, B. Mahler, Warren Bicknell, H. P. McIntosh, E. W. Moore, E. G. Tillotson, S. F. Haserot, Horace E. Andrews. The annual reports of the president and other officers were submitted, showing a marked improvement in the company's financial affairs.

ELECTRICAL SECURITIES.

The feature of greatest importance in the developments of last week was the very rapid recovery of prices from the decline of the first two days. The only excuse that can be given for the tumble in prices early in the week was the outbreak of civil strife in Russia; but that this condition was merely made use of by some speculators was very much in evidence during the latter part of the week. January and February, it is said, are dull months in the stock market. Nevertheless, it is a fact that for several days last week and the week preceding, speculation reached points which were really highest in a period of twelve months. The sudden fall in prices early in the week gave an opportunity which investors had been waiting for for some time to buy quickly. When the rise set in there was very little selling in sight. The imminence of a final decision on the Northern Securities case, along with the confidence shown by the companies principally involved, has led to a decided interest and activity in railroad securities. It is stated that the profits of the United States Steel Corporation for the December quarter will be in the neighborhood of $20,000,000, and that a very good showing will be made in regard to orders on hand.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JANUARY 28.

New York:	*Closing.*
Brooklyn Rapid Transit	61
Consolidated Gas	202¾
General Electric	185
Interborough Rapid Transit	200
Kings County Electric	200
Manhattan Elevated	170
Metropolitan Street Railway	116⅝
New York & New Jersey Telephone	170
Westinghouse Manufacturing Company	192

At the annual meeting of the Brooklyn Rapid Transit Company's stockholders no business was transacted beyond the reelection of four directors whose terms had expired, and the adoption of the usual resolution approving and confirming the official acts of the management during the year.

Consolidated Gas directors have declared the regular quarterly dividend of 2½ per cent on the capital stock, payable March 15. Books close February 24 and reopen March 16. After the meeting of the directors the resignation of President H. E. Gawtry was announced. George H. Church has been elected a trustee of the company to succeed William C. Whitney, deceased. Other trustees were reelected. The surplus earnings for 1904 are $2,600,000, compared with $2,500,000 for 1903.

Boston:	*Closing.*
American Telephone and Telegraph	143¾
Edison Electric Illuminating	250
Massachusetts Electric	60
New England Telephone	137
Western Telephone and Telegraph preferred	97½

Philadelphia:	*Closing.*
Electric Company of America	10⅝
Electric Storage Battery common	76
Electric Storage Battery preferred	76
Philadelphia Electric	10
Philadelphia Rapid Transit	25
United Gas Improvement	108¾

Chicago:	*Closing.*
Chicago Telephone	140
Chicago Edison Light	150
Metropolitan Elevated preferred	60
National Carbon common	41
National Carbon preferred	114
Union Traction common	12
Union Traction preferred	46½

The Commonwealth Electric Company has increased its capital stock by $750,000, the new issue being taken at par by the Chicago Edison Company, which holds, through trustees, all the stock of the Commonwealth company.

The earnings of the Chicago Telephone Company for 1904 broke all records. The gross revenue was $6,373,116, against $5,534,590 for 1903, or a gain of $838,525. Net earnings were at the rate of nearly 11.7 per cent on the $14,000,000 of capital stock, compared with about 10.15 per cent last year. In this report to the stockholders, President Arthur D. Wheeler announced that at the end of 1904 there were 3,600 unfilled requests for telephones. At the close of 1900 there were 36,414 subscribers' stations. In the succeeding four years the number increased to 117,893, an average of over 20,000 stations a year, distributed as follows: 1901, 17,097; 1902, 25,532; 1903, 22,144; 1904, 16,706.

The annual report of the South Side Elevated Railroad for the year ended December 31, 1904, is as follows: gross, $1,574,829; expenses and taxes, $969,975; net, $604,854; interest and dividends, $442,899, leaving a surplus of $161,955, as compared with $242,051 for 1903, and $178,631 for 1902. At the annual meeting of the company, C. J. Blair retired as a director, and was succeeded by C. H. Hubbard. Other retiring directors and officers were reelected.

NEW INCORPORATIONS.

ROME, OHIO—Rome Telephone Company. $2,000.

CASSOPOLIS, MICH.—Home Telephone Company. $25,000.

BROOKVILLE, KAN.—Brookville Telephone Company. $5,000.

FRANKFORT, KY.—Jobez & Bart Telephone Company. $500.

SAN JOSE, CAL.—National Park Electric Power Company. $25,000.

STATE COLLEGE, PA.—Nittanny Light, Heat and Power Company. $10,000.

HARRISBURG, PA.—Columbia Electric Light, Heat and Power Company. $10,000.

MILWAUKEE, WIS.—Iron River Water, Light and Power Company. $100,000.

ROANOKE, IND.—Roanoke Telephone Company. Increased from $2,500 to $10,000.

RALEIGH, N. C.—Asheboro Electric Company. $50,000. Incorporators: W. C. Hammer, A. M. Rankins and others.

PORTLAND, ME.—National Light, Heat and Power Company. $5,000,000. Incorporators: M. W. Baldwin and J. J. Hernan.

LITTLE ROCK, ARK.—Clarksville Telegraph Company. $5,000. Incorporators: C. E. Robinson, W. H. Harris and L. C. Robinson.

KIRKSVILLE, ILL.—Kirksville Mutual Telephone Company. $2,400. Incorporators: O. M. Hale, E. R. Boggs and T. J. Williams.

BURKEVILLE, TEX.—Texas & Louisiana Telephone Company. $5,000. Incorporators: E. F. Montgomery, J. C. Townsend and others.

PORTLAND, ME.—Northwestern Power Company. $10,000,000. President, J. C. Rice, Boston, Mass.; treasurer, C. M. Drummond, Portland.

AURORA, IND.—Farmers' Cooperative Telephone Association. $1,000. Incorporators: Nelson Grimsley, Herbert N. Christy and David E. Clements.

BATAVIA, N. Y.—Batavia Light and Power Company. $100,000. Directors: Seth W. Warren, George R. Howard, Buffalo; Barber B. Conable, Warsaw.

HAMILTON, OHIO—Hamilton Gas Light and Coke Company. Changed to Hamilton Gas and Electric Company, and capital increased to $1,000,000.

TOWER HILL, ILL.—South Tower Hill Mutual Telephone Company. $1,500. Incorporators: John W. Jones, Sweer S. Hertell, Charles J. Simmons.

AUSTIN, TEX.—Northwest Texas Telephone Company, of Canyon City. $10,000. Incorporators: J. N. Donohoo, R. W. O'Keefe, L. T. Lester, all of Canyon City.

TERRE HAUTE, IND.—Terre Haute & Indiana Southern Railway Company. $1,500,000. Incorporators: James R. Riggs, Charles L. Davis, Joseph Moss, of Sullivan.

HARRISBURG, PA.—Fleetwood Electric Light Company. $5,000. Directors: George B. Schaeffer, of Reading; H. E. Ahrens, of Reading, and S. K. Hoffman, of Hamburg.

ROYSE, TEX.—Royse Milling and Light Company; to operate an electric light plant and grist mill. $20,000. Incorporators: J. E. Poynter, C. E. Poynter and J. N. Miller.

WILSON, ARK.—The Wilson Northern Railway Company. To construct a railway from Wilson to Keiser, a distance of ten miles. $100,000. Directors: Robert E. L. Wilson, of Memphis, Tenn., and others.

SPRINGFIELD, ILL.—Springfield & Western Railway Company; to construct an interurban railway from Springfield through the counties of Sangamon, Schuyler, Morgan, Cass, Brown, Pike and Adams to Quincy.

EAST ST. LOUIS, ILL.—Troy & Suburban Railway Company. $50,000. Incorporators: L. C. Haynes, J. M. Bramlette and T. W. Gregory, of East St. Louis, Ill.; M. W. Schaefer and James A. Farmer, of Belleville, Ill.

COLUMBUS, OHIO—Lima, Findlay & Toledo Railway, of Lima; to construct and operate an electric line from Lima to Findlay. $700,000. Incorporators: E. Sanburn, Frank Butler, J. H. Griswald, C. L. Stocker and N. S. Harris.

GUTHRIE, OKLA.—Guthrie Railroad Company; to construct a line from Guthrie to Edmond. $600,000. Incorporators: George H. Brauer, W. J. Faulkner, of Oklahoma City; J. R. Coltingham, G. M. Green and L. N. Beadles, of Guthrie.

COLUMBIA, S. C.—Sumter Electric Light and Railway Company, of Sumter. $200,000. Incorporators: W. C. Brister, Albert DeHaven, both of Philadelphia; E. M. Beale, of Lewisburg, and J. L. Almett and H. F. Wilson, of Sumter.

SILOAM SPRINGS, ARK.—Northwest Arkansas Electric Company. To build a line of electric railroad from Siloam Springs to adjacent cities and towns. $960,000. Incorporators: L. D. Moore, of St. Louis, A. W. Perry, John P. Logan, Tom Williams and D. J. Godbold.

CHARLESTON, W. VA.—The Grafton Railway and Light Company. To construct an electric railway and an electric light plant in the city of Grafton, W. Va. $400,000. Incorporators: W. E. Horton, George W. Powell, T. B. Bradshaw, Thomas F. Job and W. E. Hildebrand, of Pittsburg.

VAN BUREN, TENN.—The Van Buren Electric Railway and Bridge Company. To construct a street railway in Van Buren and an interurban line between Van Buren, Alma and Mulberry, in Crawford County. $500,000. Philip D. Scott, president; directors: Charles H. Drennen, C. L. Scott, J. S. Dunham and L. H. Southmayd.

ENGINEERING SOCIETIES.

NEW YORK ELECTRICAL SOCIETY—An important meeting of the New York Electrical Society will be held on February 15. Mr. H. H. Vreeland, president of the New York City Railway Company, will address the members on the subject of the development of street railway systems.

AMERICAN ELECTROTHERAPEUTIC ASSOCIATION—The next annual meeting of the American Electrotherapeutic Association will be held at the New York Academy of Medicine, 17-21 West Forty-third street, New York city, on Tuesday, Wednesday and Thursday, September 19, 20 and 21, 1905. The secretary, Clarence E. Skinner, 67 Grove street, New Haven, Ct., requests the members to notify him of any change of address.

PHILADELPHIA SECTION OF THE AMERICAN ELECTROCHEMICAL SOCIETY—A regular meeting of the Philadelphia section of the American Electrochemical Society was held on Friday evening, February 3, at 22 South Fifth street, Philadelphia. A paper by Dr. G. P. Scholl, on "Modern Types of Electroplating Machines," was read and discussed. The change of meeting place was necessitated by the growing attendance at the meetings.

MADISON BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—At the last meeting of the Madison branch of the American Institute of Electrical Engineers held on Thursday evening, January 26, the subject of "The Maximum Distance to Which Power May Be Transmitted Economically" was discussed. Mr. O. O. Wagle, student, abstracted Mr. Mershon's paper, and Mr. G. A. Rodenbaeck reviewed the New York discussion. The meeting was well attended, and a great deal of interest was shown in the general discussion.

TORONTO BRANCH OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The thirteenth regular meeting of the Toronto branch of the American Institute of Electrical Engineers was held at the Engineers' Club, 96 King street West, on January 13. A paper entitled "The Relative Advantages of a 250-500-Volt, Three-Wire, Continuous Distribution for the Business Districts of Large Cities" was prepared by Mr. R. G. Black, opening a discussion upon this subject. An ideal condition was assumed by Mr. Black, and the different alternating-current systems briefly referred to. The direct-current systems were discussed, and Mr. Black concluded by advocating the use of a 250-500-volt direct-current system. Mr. C. H. Wright questioned the efficiency of such a system. While the increase of voltage would cut down the cost of copper it might not satisfy the customer. The supplying of motors from lighting mains would cause excessive fluctuation in the lamp voltage.

PERSONAL MENTION.

MR. W. W. VAUGHAN has been appointed superintendent of the Austin, Tex., division of the Southwestern Telephone and Telegraph Company.

MR. FRED L. BLENDINGER has been appointed purchasing agent and superintendent of telegraphs of the Lehigh Valley Railroad Company. He will have offices at 228 South Third street, Philadelphia, and at 143 Liberty street, New York city.

MR. JAY PARSONS, of Maumee, Ohio, formerly district manager of the American District Telephone and Telegraph Company, at Maumee, has been appointed manager of the South Bend, Ind., exchange of the Central Union Telephone Company.

MR. FRED G. CHENEY, chief operator in the Clinton, Mass., office of the New England Telephone and Telegraph Company, has been appointed manager of the company's office at Lawrence, Mass. Mr. Cheney has been associated with the company since 1889.

MR. AUGUST BELMONT, president of the Interborough Rapid Transit Company, was the principal speaker at the annual banquet of the Chicago Real Estate Board, at the Auditorium Hotel, Chicago, Ill., January 19. Mr. Belmont spoke on municipal transportation facilities, particularly in their relation to a subway system.

PROFESSOR F. A. FISH, of the State University of Ohio, has been elected by the board of trustees of the Iowa State College, at Ames, Iowa, to succeed Professor B. S. Lanphear, deceased, in the electrical engineering department. Professor Fish was educated in the University of Ohio and the University of Wisconsin, and for a number of years has been engaged in electrical work.

MR. WALTER S. TIMMIS has established an office for the conduct of a consulting engineering practice at 150 Nassau street, New York city. Mr. Timmis is making a specialty of equipping printing plants with the electrical drive. He has had a very wide experience in this class of work, having recently equipped the large plant of the Sackett & Wilhelms Lithographing and Printing Company, Brooklyn, N. Y.

MR. CHARLES L. MICHOD, of Colorado Springs, Col., has been appointed general manager of the Interstate Electric Company's business for the island of Cuba. Mr. Michod has been making an extensive trip over the island, and has come in contact with many officials of the various industries. He is of the opinion that a large business can be built up in the supply line and contracting. His permanent address is at Empedrado, Cuba.

MR. ERNEST H. DAVIS, president of the National Electric Light Association, in an able letter to the Brooklyn Daily *Eagle* of January 20, calls attention to discrepancies in the report on the Chicago, Ill., municipal lighting plant. Mr. Davis points out wherein, in a municipal bookkeeping system, a great many charges are omitted which should properly be charged against the plant. A conservative estimate of these expenses per annum places the charge at $283,434.88. This, placed against the record which the municipal plant has made, would show a loss to the city of nearly $50,000.

MR. WILLIAM H. BLOOD, JR., has been appointed chairman of the committee on district heating of the National Electric Light Association. He expects to present a very full and important report on this branch of central station industry. The other members of the committee are C. R. Maunsell, Topeka, Kan., and R. S. Wallace, Peoria, Ill. Both of these men have had personal experience with steam and hot-water heating plants, and have also given the subject extensive study and observation. The association has made a liberal appropriation for carrying on investigations coincident with this work.

PROFESSOR REGINALD A. FESSENDEN, the distinguished inventor, has been appointed to the municipal power commission of Ontario, Canada. Mr. Fessenden was born in Milton, Quebec, was educated at Trinity College School, Port Hope, and has held many important positions in the world of electrical engineering. He has been entrusted with special expert investigations by the United States government, and has held prominent positions with the Westinghouse Electric and Manufacturing Company, the General Electric Company and the New York Edison Company. For the past fourteen years he has been connected with a number of important American power development projects. His work in wireless telegraphy has won him wide fame, and his system is one of those which the United States navy has under consideration.

MR. W. F. DAVIDSON has tendered his resignation as secretary and treasurer of the Port Huron, Mich., Light and Power Company. Mr. Davidson was one of the organizers of this company, and has been manager of the business ever since its inception. Some time ago Mr. Davidson was injured in a railroad accident at the Hyde Park station, Chicago, Ill., and has been in ill health ever since.

MR. M. T. THOMPSON has resigned as superintendent of construction work of the Mexican Light and Power Company, Limited. The company is undertaking considerable construction at Necaxa, Mexico. The engineering staff of the company is now being reorganized, and Mr. F. S. Pearson, vice-president and consulting engineer of the company, will probably appoint Mr. Thompson's successor. Mr. Thompson will establish an office in the city of Mexico.

MR. W. N. STEVENS, who has for some filled the position of assistant mechanical engineer of the Rapid Transit Subway Construction Company, has accepted a position with J. G. White & Company, of 43 Exchange place, New York city. Mr. Stevens has had a wide experience as a constructing engineer in the designing and active construction of important power plants. He had much to do with the design and construction of the Twelfth street power-house of New York Edison Company. He also has had charge of the design and construction of the mechanical equipment of the Seventy-fourth street power-house, and has lately been engaged on the work of designing and building the Fifty-ninth street power-house, nine transformer stations, car barns, shops, and other adjuncts, to the construction and equipment of the Interborough rapid transit in New York city. During his professional career, Mr. Stevens has also been engaged in engineering undertakings in other parts of this country and abroad, he having made both the preliminary and afterward the final plans for the machinery of the power-house for the tramways of Sydney, Australia. J. G. White & Company are to be congratulated in having secured the able service of Mr. Stevens in their mechanical engineering department.

NEW PUBLICATIONS.

TRANSACTIONS OF THE AMERICAN CERAMIC SOCIETY—Vol. vi of the Transactions of the American Ceramic Society has been published. This book contains the papers and discussions of the sixth annual meeting, held at Cincinnati, Ohio, February 1 to 3, 1904.

ANNUAIRE POUR L'AN 1905—This is the annual publication of the bureau of longitudes of Paris. It contains a complete astronomical calendar, a good deal of geographical information, and some statistics of general interest. There are, in addition, a number of valuable tables of weights and measures, interest, computation, etc.

TERRESTRIAL MAGNETISM—The results of the magnetic observations made by the United States Coast and Geodetic Survey, department of commerce and labor, Washington, D. C., between July 1, 1903, and June 30, 1904, are contained in a pamphlet issued as an appendix to report No. 3, for 1904, on terrestrial magnetism. It is edited by Dr. L. A. Bauer. It describes the new type of instrument which is in use, and discusses the methods of observing and the general accuracy of the results. Stations located in twenty-four states are described.

TRANSACTIONS OF THE AMERICAN RAILWAY MECHANICAL AND ELECTRICAL ASSOCIATION—The report of the second annual convention of the American Railway Mechanical and Electrical Association, held at St. Louis, Mo., October 10, 11 and 14, 1904, has been issued. The frontispiece is an excellent photogravure of the president of the association for 1903-1904, Mr. Edwin W. Olds. This volume includes all of the papers read at this second annual convention, with the discussion in full. There is also a list of the active and associate members of the association.

ELECTRIC LIGHTING.

GOSHEN, N. Y.—Improvements costing $40,000 have been made to the Newton electric lighting plant.

GREELEY, COL.—Work has begun on a $20,000 water and electric light plant for the town of Evans.

BIDDEFORD, ME.—The York Light and Heat Company will expend about $40,000 in new machinery and other improvements.

CHARLESTON, MD.—A franchise has been granted to a new electric light company to erect poles and string wires at Chestertown.

CRESTON, IOWA—The Corning Electric Light Company, which has been in the hands of a receiver for some time, has been sold to Charles Munns for $6,000.

LAUREL, MISS.—The electric lighting and power plant of the Laurel Improvement Company has been destroyed by fire. The loss is $14,000, with insurance of $8,000.

MARQUETTE, MICH.—The Marquette light and power commission has closed a $3,300 contract with the Westinghouse company for 125 alternating-current street lamps, two seventy-five-lamp converters, switchboard panels and other equipment.

LA CROSSE, WIS.—Application has been made by Walter B. McDonald for a franchise, allowing the Chicago Electric Light Company to furnish light for the city of Onalaska. An application will also be made to the common council of La Crosse for a franchise to furnish current to that city.

YORK, PA.—Plans are now being considered and perfected by the York Haven Water and Power Company for the construction of cable lines to Harrisburg, Steelton and Middletown, for the transmission of electric power from the plant to these towns. It is planned to supply power by July.

ELBERTON, GA.—O. H. Sheffield, of Atlanta, who has charge of the work of damming the Savannah river at the lower edge of Elbert County for the purpose of putting in a large electric plant and other machinery, has completed his arrangements, and hopes at an early date to have the plant completed.

ALBANY, N. Y.—The Colonie Electric Company election resulted as follows: directors, H. M. Sage, J. H. Jackson, F. W. Joslin, A. T. Benjamin, J. D. Johnson, T. C. Murray and J. A. Lawson. The directors elected: president, Henry M. Sage; vice-president, John H. Jackson; secretary and treasurer, Joseph A. Lawson; general manager, Francis W. Joslin.

GREENVILLE, OHIO—The result of the election held by the stockholders of the Greenville Electric Light and Power Company was the selection of the following gentlemen to serve as directors during the coming year: Z. T. Dorman, W. T. Fitzgerald, L. C. Anderson, J. M. Bickel, D. L. Gaskill, A. C. Robeson, Sam. Harnish, John Whiteley and A. J. Klinger.

NIAGARA FALLS, N. Y.—At a meeting of the town board of Cambria a franchise was granted the Niagara, Lockport & Ontario Power Company to construct and maintain a transmission line through the town for the conveying of electricity for power, heating and lighting purposes. The franchise carries with it an obligation to expend $50,000 within one year from the time of the granting of the franchise.

NASHVILLE, TENN.—The superintendent of the Nashville electric light plant has submitted his report. This shows that during the past year there have been put in service eighty-four arc lamps and 448 incandescent lamps, making a total of 726 arc lamps, and 2,331 incandescent lamps connected to the plant. The total output of the plant was 1,898,474 kilowatts, and the cost of operation, $32,667.86.

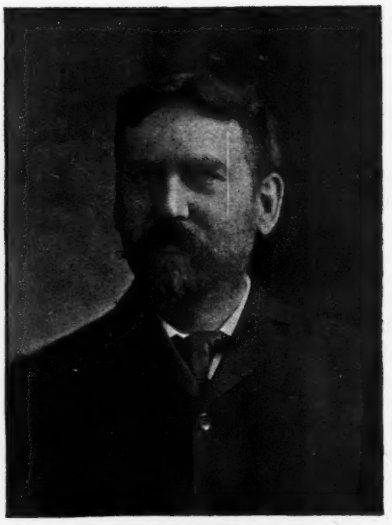
TOWANDA, PA.—M. J. McMahon and W. H. Sullivan have been granted a franchise under the name of the Galeton Electric Heat, Light and Power Company, to furnish electric light for Galeton and to operate a trackless trolley line. The plant will cost from $30,000 to $40,000. The franchise limits the time in which they must have the lighting plant and three miles of trolley road in operation to six months.

TERRE HAUTE, IND.—C. William Whaley and Noland B. Stadley have been granted a twenty-year franchise for lighting the town of Shelburn. The plant will be located halfway between Shelburn and Hymera, as the latter town will also be lighted. The plant will be built at once and will be equipped with a 350-horse-power engine and a 250-kilowatt dynamo. Twenty arc lights will be maintained in Sheburn at a cost of $50 per year each.

LA GRANDE, ORE.—The Grande Ronde Electric Power Company is arranging to build a power-house at the cove, sixteen miles from here, where it will secure power from Mill creek and the Minam to furnish more power to La Grande and light to Union, Hot Lake and Cove. The power-house to be constructed at the cove will be entirely of stone, according to present plans, and will be thirty by thirty-four feet. It will contain a 550-horse-power Pelton wheel.

OBITUARY NOTICE.

MR. EDWARD HEMPHILL MULLIN, whose death was announced in these columns last week, died very suddenly from heart disease on Wednesday, January 25. Mr. Mullin was an old-time newspaper man of very extensive acquaintance and high attainment. He was born in Castlederg, County Tyrone, Ireland, on October 22, 1859. He was educated at the Methodist College Public School, of Belfast, Ireland, and Queen's College, Belfast, where he took his bachelor's degree with honors in physics and chemistry in 1881. Shortly afterward he came to New York and engaged in newspaper work. From 1887 to 1895 he was an editorial writer on the staff of the New York *Evening Sun*. The two following years he spent on the staff of the New York *Times* in charge of the technical reporting of that newspaper. Subsequently he became editor of the *Bookbuyer* and a prolific contributor to the magazine and technical press. On February 1, 1898, he entered the service of the General Electric Company, at first as manager of its advertising department and latterly as a confidential representative of the company in many matters. He was the authorized representative of the company in all relations with the press, and the official host of the company whenever foreign engineers or capitalists desired to visit its works. He was a thirty-second-degree mason, a member of the Engineers', Press and Transportation clubs, vice-president of the New York Electrical Society, a director of the American Institute of Electrical Engineers, and also vice-president of the Association of American Advertisers. Mr. Mullin had a great number of friends here and abroad, and was known among them for his erudition and wide acquaintance with electrical and engineering subjects. He was a consistent student, and as a writer was distinguished for clarity of style and an Anglo-Saxon simplicity of diction which made his essays on mechanical and electrical matters very easy reading. The funeral services were held at Milburn, N. J., at two o'clock, on Saturday, January 28, and the interment was at Milburn later in the afternoon. Several of the societies and organizations of which Mr. Mullin was a member were well represented, and many prominent in the various branches of electrical engineering were also present. Among those present were Messrs. John J. Carty, Ralph W. Pope, John A. Lieb, F. C. Bates, Calvin W. Rice, Professor G. F. Sever, G. A. Hamilton, I. Keeler, J. J. Mahony, L. R. Pomeroy, J. McGhie, H. D. Hawk, Stephen H. Goddard and J. Beran.



MR. EDWARD HEMPHILL MULLIN.

TELEPHONE AND TELEGRAPH.

SHELDON, IOWA—The Sheldon Telephone Company has been granted a local franchise.

LITTLE ROCK, ARK.—Lonoke is to have another long-distance telephone connection with Little Rock.

DETROIT, MICH.—Farmers of Johnson township, Calhoun County, have built a telephone system with an exchange at Lacey.

PERRY, FLA.—W. A. Hendry and allied interest have bought the entire stock of the Perry Telephone Company, except that of J. T. Blair.

LONG BEACH, CAL.—The Home Telephone Company will increase the capacity of its switchboards in Long Beach by 600 connections.

NIAGARA FALLS, N. Y.—The Niagara County Home Telephone Company is planning to erect a new exchange building in Niagara Falls.

JOHNSTOWN, PA.—The Somerset Telephone Company has installed an all-night service, and the exchange in Somerset and Meyersdale will be open continuously.

PORTSMOUTH, N. H.—The New England Telephone and Telegraph Company has purchased a lot of land in Concord and, it is said, will erect a modern central station in that city.

ARDMORE, I. T.—A new telephone exchange, with the latest equipment and to cost from $40,000 to $50,000, is to be installed at South McAlester immediately by the McAlester-Eufaula Telephone Company.

ORANGE, N. J.—The West Orange town council has passed an ordinance, the life of which will be fifty years, granting a franchise to operate in Orange to the New York & New Jersey Telephone Company.

WASHINGTON, N. C.—The Western Union Telegraph Company has completed a new wire between Richmond, Va., and Washington, placing the latter city in direct telegraphic communication with Richmond.

PORTLAND, ORE.—A new rural telephone company has been organized in the Alsea country, known as the Fall Creek Company. Connection is to be made with the Alsea rural line, which has about fifty telephones.

SILVERTON, ORE.—An independent telephone company has been formed to connect Silverton with the adjoining towns. P. L. Brown is the local representative. The new company will be known as the Interurban Telephone Company.

CAMDEN, TENN.—A franchise to operate an exchange in Camden has been granted the Cumberland Telephone and Telegraph Company by the mayor and board of aldermen. The Cumberland company recently bought out the Camden city exchange.

MORENCI, OHIO—The Morenci Telephone Company has elected the following directors and officers: W. W. Crabbs, C. D. House, Ambrose Combs, L. A. Kennedy, Darwin Osgood, directors; W. W. Crabbs, president and manager; Ambrose Combs, secretary and treasurer.

TIVERTON, R. I.—A new telephone system is to be installed in Tiverton by the Strowger Automatic Company. Automatic telephones of an improved style are also to be installed in Little Compton, Tiverton Four Corners and Tiverton proper. Construction work will begin in the spring.

WATERTOWN, N. Y.—At the annual meeting of the Alexandria Bay Telephone Company the following officers were elected: president, G. L. Olds; secretary and manager, William E. McDonell; treasurer, Charles U. Putnam. The company at present is in a prosperous condition, and is contemplating extensive improvements.

LITTLE ROCK, ARK.—The St. Louis, Iron Mountain & Southern Railway and the Western Union Telegraph Company have begun the work of rebuilding the telegraph line from Little Rock to Malvern. It is estimated that with ordinary success it will require upward of four months to complete the work, which will cost $25,000.

HOOPER, NEB.—The following have been elected directors of the Hooper Independent Telephone Company: T. B. Pairling, Bernard Monnich, M. E. Shipley, J. Howard Heine, H. Meyer, T. W. Lyman, E. O. Spielberg, H. Bartling, M. A. Wehling, August Heller. The company has three lines running out of Hooper, and has connection with all the important independent lines.

ELIZABETH, N. J.—The Interstate Telephone Company, of which the Elizabeth Telephone Company is a branch, is connecting the various towns in New Jersey and Pennsylvania in which it has branches. The connecting lines run from Elizabeth to Trenton, taking in the principal Jersey towns south of Trenton, thence to Philadelphia. A large number of Pennsylvania towns is brought together.

ELKHART, IND.—The Home Telephone Company has elected the following directors: president, I. W. Short, of Elkhart; vice-president, J. A. Arthur, of Goshen; treasurer, H. B. Sykes, of Elkhart; secretary and manager, J. K. Johnston, of Elkhart; G. W. Miller, J. B. Pollard, James Kavanagh and Wilson Roose, of Elkhart, and E. L. Barber, of Cleveland.

MOBILE, ALA.—At the annual meeting of the Home Telephone Company the following officers and directors were installed for the ensuing year: John Craft, president; A. S. Lyons, vice-president; A. Proskauer, treasurer; R. L. Douglas, secretary; W. H. Bryant, manager; directors, John Craft, A. H. Spira, Adam Glass, P. J. Lyons, L. C. Fry, J. K. Glennon, A. S. Lyons, S. C. Schaffner, William Vizard.

KINGSTON, N. Y.—The independent telephone companies at Delhi, Franklin, Walton, Sidney, Hancock and Deposit, and the Davis Telephone Company and Rose Telephone Company, the principal independent lines in Otsego, Delaware and Broome counties, having an aggregate of 2,500 subscribers, have made a traffic arrangement with the Bell Telephone Company by which their patrons are connected with the Bell system.

DAYTON, IOWA—The stockholders of the Dayton Telephone Company at their annual meeting reelected their old directors and officers, and voted to increase their capital stock from $10,000 to $25,000. The company has proved a prosperous one since its organization, and is planning to extend its service during the coming season, instituting new exchanges and building new lines, as well as substantially improving its present service.

DULUTH, MINN.—At the annual meeting of the Duluth Telephone Company C. H. Graves, of Duluth, was reelected president; C. P. Wainman, of Minneapolis, general manager; and C. M. Mauseau, of Duluth, assistant general manager. During the year about $75,000 will be expended for improvements. In the city of Duluth 4,000 to 5,000 feet of 400-pair underground cable will be installed, and several miles of 50 to 100-pair aerial cable will be put in place.

BALTIMORE, MD.—The Chesapeake & Potomac Telephone Company has put its new exchange, "Wolfe," into operation, taking about 2,500 subscribers off the switchboard at the congested Mount Vernon exchange, which has been overcrowded for several months, on account of the fire of last February. In the annual report of the company the receipts are shown to be $604,630.87, telephone earnings, and $39,041.09, real estate earnings, a total of $643,671.96. The total expenditures are given as $629,561.03, and the net earnings as $14,110.93. The total receipts on account of capital in the District of Columbia are shown to be $476,118.84. The expenditures, amounting to this sum, are divided as follows: for construction of underground conduits and cables, $148,007.93; construction of poles, aerial wires and fixtures, $41,541.70; for central office equipment, $286,569.21. The cost of the works is given as $2,462,263.59.

NEW COMPANIES.

MALDEN, MASS.—The Continental Motor Company has been organized with a capital of $1,000,000. The incorporators are Albert E. Knowlton, Harold P. Knowlton, both of Malden.

INDIANAPOLIS, IND.—The Maier-Oliphant Electrical Company, with a capital of $5,000, has been incorporated by Frank L. Maier, Lee H. Oliphant and Lewis Maier.

ALBANY, N. Y.—The Federal Sign System, of New York city, has been incorporated with a capital of $1,000,000 to deal in electrical supplies and devices. The directors are Edward Butcher, Jr., C. L. McFetrish and W. H. McClain, of New York; J. M. Gilchrist, of Chicago, and J. H. Grenelle, of Brooklyn.

INDUSTRIAL ITEMS.

PASS & SEYMOUR, INCORPORATED, Solvay, N. Y., is distributing a number of leaflets giving new prices on its various specialties. These are designated as price lists No. 81 and No. 82, and cancel the lists given in price lists No. 70 and No. 80.

ALBERT ROTHERMEL, 686 East One Hundred and Forty-ninth street, New York city, is requesting catalogues of hardware and electrical supplies. Mr. Rothermel has opened a large store at the above address, and will carry a complete stock of these supplies.

THE CENTURY ELECTRIC COMPANY, 1007 Locust street, St. Louis, Mo., announces its removal on February 1 to 404 North Fourth street, where it will have much larger and better quarters to take care of its rapidly increasing ceiling fan and power motor business.

THE NATIONAL ELECTRIC COMPANY, Milwaukee, Wis., is distributing a handsome calendar for 1905. The calendar pad is rather small, but the mat is made very attractive by a reproduction of the painting by Thomas Blinks, entitled "The Thoroughbreds."

THE WESCO SUPPLY COMPANY, Seventh street and Clark avenue, St. Louis, Mo., is distributing a new catalogue descriptive of the Wesco telephone. This takes up in detail the various parts of the telephone apparatus, illustrating each and giving a careful description of the mechanical and electrical features.

THE HANCOCK INSPIRATOR COMPANY, New York city, has prepared a pocket-sized catalogue descriptive and illustrative of the Hancock inspirator for stationary, marine and locomotive service; Hancock ejectors and general jet apparatus. In addition to a careful description of the apparatus, complete lists of prices are given.

THE EASTERN ELECTRIC COMPANY, Boston, Mass., manufacturer of incandescent lamps, has opened a branch office at 5 Beekman street, New York city. Mr. L. V. Weil will be in charge of this office. The company has greatly increased its productive capacity, and will be able to fill orders promptly from the new office.

THE UNITED TELPHERAGE COMPANY, 20-22 Broad street, New York city, has published a handsome catalogue descriptive of electric telpher apparatus. The work covers twenty-four pages, and is entirely made up of reproductions of typical installations. Some of these show the successful solution of difficult problems in the transport of material.

THE H. O. S. ENGINEERING COMPANY, New York city, has removed its factory and general office from 88 Warren street to 16-22 Boyden place, Newark, N. J. The company will be able to manufacture its line of goods to better advantage, and it has installed a very complete plant which will enable it to satisfy the trade in every respect much better than heretofore.

THE STANDARD VITRIFIED CONDUIT COMPANY, 39-41 Cortlandt street, New York city, is distributing an attractive folder calling attention to its various forms of vitrified single and multiple-duct conduit. The frontispiece is an illustration showing the company's conduit in process of installation at the power-house of the Niagara Falls Power Company, Niagara Falls, N. Y.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., is distributing bulletin No. 117, descriptive of Gates rock and ore breakers, styles D and F, and auxiliary machinery. Sectional and assembled views of these gyratory rock and ore breakers are shown. There is also a careful description of the apparatus and its applications, together with diagrams giving dimensions and weights.

THE PITTSBURG TRANSFORMER COMPANY, Pittsburg, Pa., is calling attention to its pipe-thawing outfits. At this time of the year considerable damage is being done to water pipes due to freezing. The old method of digging up the street and thawing out by the application of a flame is giving way, in almost every city of any importance, to the scientific application of the electric current.

THE NATIONAL CARBON COMPANY, Cleveland, Ohio, is distributing a valuable and attractive calendar for 1905. The mat is illuminated by a beautiful velox portrait. The calendar pad contains a lighting schedule for each month. The dates are so arranged that the lighting hour for each day is easily determined. At the bottom of each page the total lighting hours for the month are indicated.

THE MICHIGAN CENTRAL, Niagara Falls route, has prepared two new time-tables and reference books which are of great interest to travelers. The first takes up the system between New York, Boston, Buffalo and Chicago, the West and Northwest, and the second the Chicago-Grand Rapids line. Either of these booklets may be had from Mr. O. W. Ruggles, general passenger and ticket agent, Chicago, Ill.

THE AMERICAN CONDUIT COMPANY, 822 Manhattan Building, Chicago, Ill., has a corps of experts in underground construction, and is prepared to furnish supervision of work if desired. The company prefers to cooperate with contractors in underground construction, but, if desired, will submit estimates and bids and take contracts for completed underground systems in all parts of the United States or Canada.

W. N. MATTHEWS & BROTHER, 200 Carleton Building, St. Louis, Mo., are working on a new thirty-two-page catalogue, devoted entirely to the Stombaugh guy anchor. This is to be the most attractive piece of literature that this enterprising firm has sent out. The company expects to have it ready for distribution about March 1. It should prove of great interest to those who have poles to anchor. The catalogue will be sent upon request.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., is sending out several attractive folders calling attention to P-K cartridge fuse cutouts and P-K panel cutouts and boxes. On April 1 the new standard for enclosed fuses goes into effect. The new code standard cartridge fuse blocks, which the H. T. Paiste Company is placing on the market, will take any new code fuse of any standard make. The circulars which the company is distributing show a full line of these devices.

A. L. IDE & SONS, Springfield, Ill., announce that they have established a New York office at 11 Broadway. All export, New England and Middle States business will be transacted at this office hereafter, under the management of Mr. J. G. Robertson. A. L. Ide & Sons are the original manufacturers and patentees of the celebrated "Ideal" engines. These engines are being used extensively in manufacturing establishments, office buildings and for power and electric plants.

THE HAYDEN & DERBY MANUFACTURING COMPANY, New York city, has prepared a pocket-sized edition of its large catalogue descriptive and illustrative of Metropolitan ejectors. The Hayden & Derby Manufacturing Company makes the Metropolitan automatic injectors, Metropolitan "1898" injectors, Metropolitan double-tube injectors, H-D injectors and jet apparatus. All of this apparatus is described, and diagrams are also given showing various sizes.

MESSRS. QUEEN & COMPANY, INCORPORATED, Philadelphia, Pa., have issued a new circular in which are compiled the various instruments that the company make for resistance measurements. This list includes all types of instruments, from an elaborate and complete Wheatstone bridge and rheostats of the Anthony and Kelvin type to small individual unmounted resistance coils. The catalogue also describes in detail Queen & Company's "Acme" and "Decade" sets. Considerable space is given to a description of the Queen portable cable-testing system. This catalogue is illustrated throughout, and will be sent to any one interested upon request.